State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES
Division of Planning and Local Assistance

Lower Butte Creek - Sutter Bypass Weir No. 2 Fish Passage Project

Preliminary Engineering Technical Report

December 2003

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Governor
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Michael Chrisman
Secretary for Resources
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Linda S. Adams
Director
Department of Water Resources

Foreword

Declining salmon and steelhead populations have led to increased efforts to implement restoration activities to preserve and enhance their populations, while respecting the needs of the various stakeholders. More than $25 million has been invested in fish passage and screening projects in the middle reaches of Butte Creek, resulting in dramatic increases in returning adult anadromous fish populations. The continued success of those projects can be assured through completion of fish passage improvements in the lower reaches of the complex Butte Creek system. The Lower Butte Creek - Sutter Bypass, Weir No. 2 Fish Passage Project is a part of these efforts. The objective of this project is to enhance Butte Creek's anadromous fish populations by improving fish passage past Weir No. 2 over a greater range of flows.

This report summarizes the findings of the California Department of Water Resources (DWR) preliminary engineering investigation of fish passage solutions at Lower Butte Creek - Sutter Bypass, Weir No. 2 near Yuba City, California. Included in this report are preliminary design drawings and cost estimates for project alternatives, discussion of the physical and operational characteristics of the alternatives, summary of construction issues and final design criteria. Attached appendices include meeting notes, hydrologic data, a structural evaluation, a preliminary geologic investigation memorandum, and a preliminary environmental evaluation summary. Proposed structural modifications include reconstructing Weir No. 2 and constructing a new full Ice Harbor fish ladder.

This study was funded by the Department of Water Resources' Fish Passage Improvement Program (FPIP).

DWIGHT P. Russell

Dwight P. Russell
Chief
Northern District

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All photos in this report were taken by DWR staff with the exception of Figure 13 which is credited to Obermeyer Hydro Inc.

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Organizations Consulted

California Department of Fish and Game
California Department of Water Resources
Ducks Unlimited
National Marine Fisheries Service
Sutter County
Sutter Extension Water District
United States Bureau of Reclamation
United States Fish and Wildlife Service

Recommendations

The California Department of Water Resources has completed a preliminary engineering investigation of fish passage solutions at Weir No. 2 on Lower Butte Creek in the Sutter Bypass.

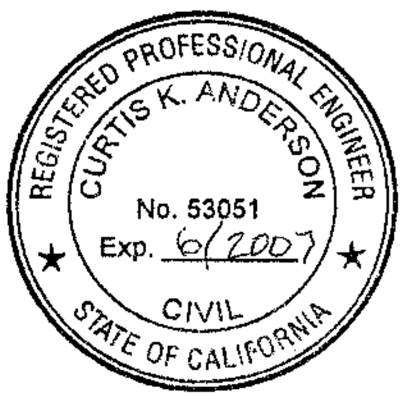
The Weir No. 2 Technical Working Group recommends advanced engineering of the following:

- Full Ice Harbor fish ladder
- New Weir No. 2 structure with 3 spillway gates

Lower Butte Creek - Sutter Bypass, Weir No. 2 Fish Passage Project

REGISTERED ENGINEERS' STAMPS

The technical information contained in this preliminary engineering technical report has been prepared by or under the direction of the following registered engineers.



Date: 12/31/2003

Abbreviations and Acronyms

AFRP	Anadromous Fish Restoration Program
cfs	cubic feet per second
CMM	Current Meter Measurement
DFG	California Department of Fish and Game
DFM	Division of Flood Management (of DWR)
DOE	Division of Engineering (of DWR)
DWR	California Department of Water Resources
EBC	East Borrow Canal
FPIP	Fish Passage Improvement Program (of DWR)
GPS	Global Positioning System
NAD	North American Datum
NAVD	North American Vertical Datum
ND	Northern District (of DWR)
NMFS	National Marine Fisheries Service
SMY	Sutter Maintenance Yard
SNWR	Sutter National Wildlife Refuge
USBR	United States Bureau of Reclamation
USED	United States Engineering Datum
USFWS	United States Fish and Wildlife Service

Introduction

This report summarizes the findings of the Department of Water Resources (DWR) preliminary engineering investigation of fish passage solutions at DWR Weir No. 2 along the East Borrow Canal (EBC) of the Sutter Bypass near Yuba City, California (Figure 1). Included in this report are preliminary design drawings, cost estimates, discussion of the physical and operational characteristics of the alternatives, summary of construction issues, and final design criteria. Attached appendices include technical design team meeting notes, hydrologic data, a preliminary geologic investigation summary, a cultural resources summary, and an environmental summary.

Project Location and Access

The Weir No. 2 project area is located in Sutter County in the EBC of the Sutter Bypass (Figure 1), approximately 27 miles upstream of the confluence of the Sacramento and Feather rivers. The project area is on State of California, Reclamation Board property.

Access for construction would be from Highway 20 at Acacia Road, proceed south about 1 mile to the Franklin Road bridge over Wadsworth Canal, cross the bridge and proceed southwest on the south levee for approximately 1 ¼ miles, the levee then turns southeast, proceed approximately 0.9 mile to Weir No. 2. Additional access is available from Highway 99 to Bogue Road, to McClatchy Road to Weir No. 2 or from Highway 99 to Oswald Road to Hughes Road to Weir No. 2.

Project Background

Declining salmon and steelhead populations have led to increased efforts to develop restoration activities to preserve and enhance these populations, while respecting the needs of various stakeholders. The Lower Butte Creek - Sutter Bypass, Weir No. 2 Fish Passage Project is a part of that effort. The objective of the project is to enhance Butte Creek's anadromous fishery by improving fish passage over a greater range of flows.

Adult anadromous fish migrate from the Pacific Ocean, up the Sacramento River, and through Lower Butte Creek, to their spawning grounds in Upper Butte Creek near Chico, California. Some fish enter the Lower Butte Creek system through Sacramento Slough and travel up the Sutter Bypass West Borrow Canal (WBC) to its confluence with Willow Slough. From Willow Slough, fish can cross over to the Sutter Bypass EBC where Weir No. 2 is located. Fish from both borrow canals reunite near the upper end of the Sutter Bypass at Butte Slough. Fish can also enter the Butte Creek system through the Butte Slough Outfall gates at the Sacramento River near Colusa, and continue their journey upstream to the cool holding pools and spawning grounds. Juvenile fish follow the same general route back to the ocean.

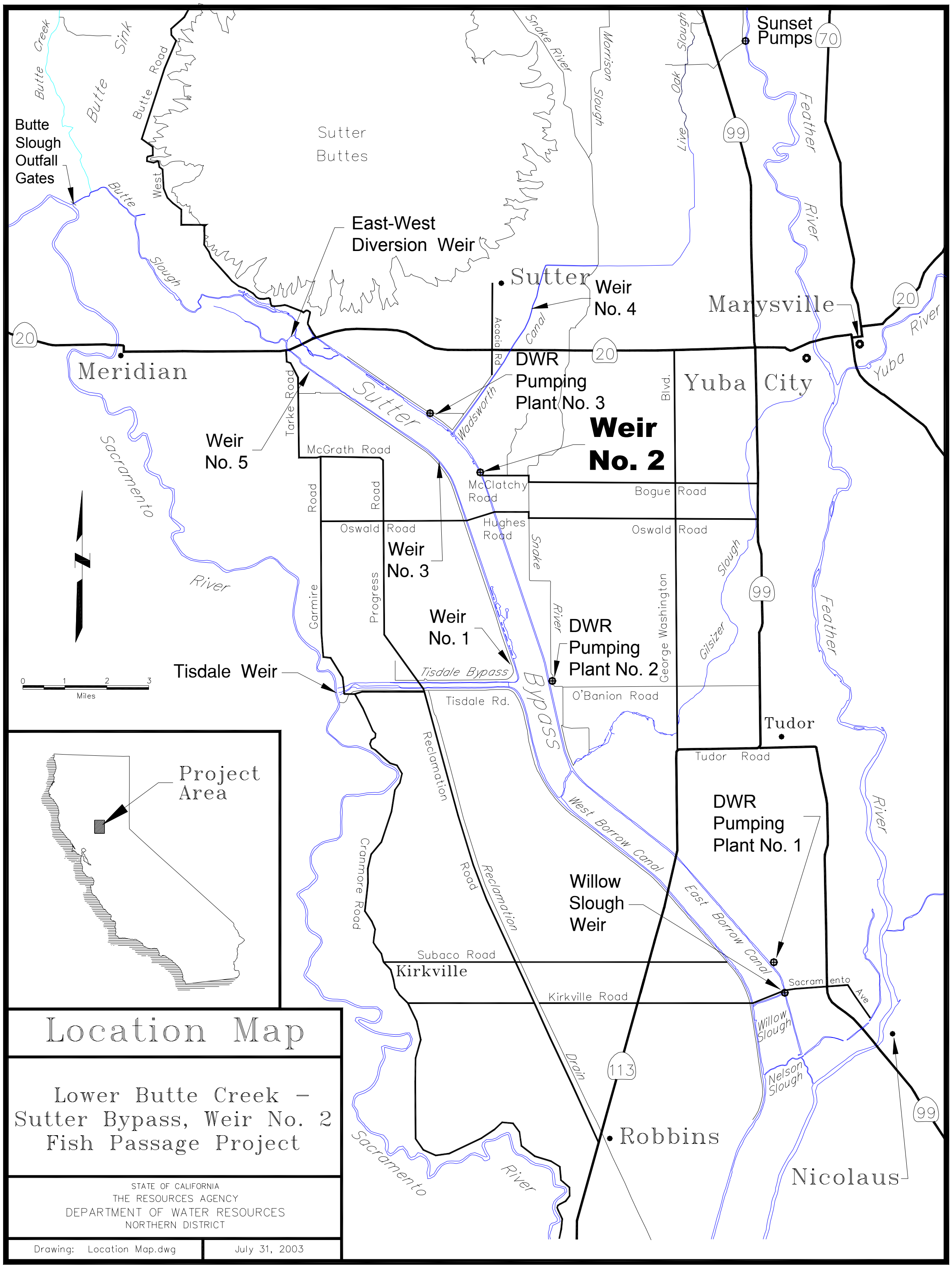


Figure 1. Location map

Weir No. 2, which is owned and operated by DWR, was originally an earthen dam that was replaced by a timber flashboard dam in 1925 after being washed out by floods. The timber flashboard dam was replaced with concrete piers in 1946 (Figure 2). The existing structure has an approximately 4-inch thick slab foundation with cutoff walls at the upstream and downstream ends. There are 11 concrete piers about 9 inches thick, 14.5 feet long, and 13 feet high. Twelve bays about 6 feet wide with flashboards control the stage upstream of Weir No. 2 (Figure 3). The concrete piers appear to have been built on the original 1925 foundation. An inspection of the structure confirmed details of the existing foundation with plans from 1925. A pool and weir fish ladder exists at the right abutment of Weir No. 2 and has four 4-foot wide weirs and two v-notch weirs (Figure 4 and 5). Upstream passage through the fish ladder is by jumping over weirs since it does not contain orifices.

Purpose and Need for Project

Improvement to Weir No. 2 is an integral part of the overall restoration efforts in the Butte Creek System. The Weir No. 2 fish ladder is one of a number of fish passage facilities in the Butte Creek system that has not been updated in recent years. The large number of fish passage and screening projects already completed has decreased delays and losses of migrating anadromous fish. Improving migration through the Lower Butte Creek system is critical to the continued success of these projects.

The objective of this project is to reduce losses of adult and juvenile anadromous fish from the Lower Butte Creek system. The existing weir and fish ladder structures have been in place for more than 50 years and are outdated. The existing pool and weir fish ladder does not meet today's standards for fish ladders and its entrance is poorly oriented to spills over Weir No. 2 (Figure 6). Passage is difficult at best with the existing ladder due to its low flow capacity and lack of sufficient steps. Water surface differences between pools are commonly around 2 feet.

The Weir No. 2 structure has been in place for more than 50 years and likely rests on a foundation constructed in 1925. The wear and deterioration that has occurred over the years has taken its toll on the structure to the point that maintaining a normal operating stage upstream for diversions and a fish ladder may not be possible during low flow periods. Excessive leakage for a typical flashboard structure and recently discovered physical defects indicate that Weir No. 2 needs major repairs or rebuilding.

Figure 2. Weir No. 2 rebuilt in 1946 (looking upstream)

Figure 3. Existing Weir No. 2 (looking upstream)

Figure 4. Rectangular weir of the existing pool and weir fish ladder

Figure 5. V-notch of the existing pool and weir fish ladder

Figure 6. Existing fish ladder entrance

Project Alternatives

DWR, Northern District (ND), was funded by DWR's Fish Passage Improvement Program (FPIP) to provide preliminary engineering designs and cost estimates for fish passage alternatives at Weir No. 2 in the EBC of the Sutter Bypass. Several stakeholder meetings were held with representatives of Ducks Unlimited, water districts, and local, State, and federal agencies to discuss the alternatives of the project. The stakeholder group considered many alternatives to improve fish passage, including those listed below. The alternatives were evaluated on numerous factors including fish passage, operation and maintenance, location and condition of existing facilities, stream characteristics, stream hydrology, site geology, biological criteria, owner liability, and economics. Eight alternatives were narrowed down to one after consultation with the fish passage stakeholder group. The selected alternative for Weir No. 2 was investigated, and the results are summarized in this preliminary engineering report.

Alternatives Considered

The initial alternatives considered for Weir No. 2 are listed below. The alternative carried through preliminary design is underlined.

- Alternative 1 – No action.
- Alternative 2 – Remove Weir No. 2.
- <u>Alternative 3</u> – Replace Weir No. 2 with a new weir and fish passage structure at the existing location (right bank or left bank fishway, or both banks).
- Alternative 4 – Replace Weir No. 2 with a new weir and fish passage structure at the existing location (right bank fishway), and tie the fish ladder into the Sutter National Wildlife Refuge (SNWR) diversion canal entrance. This would only be necessary if a fish screen became required for the SNWR diversion and the SNWR diversion point and proposed fish screen were moved down to Weir No. 2 to improve sweeping velocities past the screen.
- Alternative 5 – Replace Weir No. 2 with a new weir and right bank fish passage structure at the SNWR diversion site about 800 feet upstream of the existing structure. This would only be necessary if a fish screen became required for the SNWR diversion. The fish ladder would be tied to new fish screen facilities to improve sweeping velocities past the screen.
- Alternative 6 – Remove the existing fish ladder and replace it (in the existing right bank location) with a state-of-the-art fish ladder, possibly including an auxiliary water system. The existing weir structure would be kept.
- Alternative 7 – Remove the existing fish ladder and replace it (in the existing right bank location) with a state-of-the-art fish ladder, possibly including an auxiliary water system. Plus, tie into the SNWR diversion as described above. The existing weir structure would be kept.
- Alternative 8 – Remove the existing fish ladder and replace it (at the left bank to improve access) with a state-of-the-art fish ladder, possibly including an auxiliary water system. The existing weir structure would be kept.

Alternative 1 was abandoned because it does not meet the goals of this restoration project.

Alternative 2 was abandoned because of the dependence by numerous diverters upstream on the elevated water surface maintained by the Weir No. 2 structure. Without maintaining the current water surface, the SNWR gravity diversion would not be able to function and other diverters using pumps would be required to move pumps or pump from a lower elevation.

Alternative 3 is the option carried through preliminary design. Sub-alternatives were investigated for different diversion structure options and fish ladders.

Alternative 4 was abandoned because of the uncertainty of whether a new fish screen structure is required for the SNWR diversion. The group did not want to commit to building a new fish ladder with the intent of tying into a new fish screening facility that may not be built in the future.

Alternative 5 was abandoned because of the uncertainty of whether a new fish screen structure is required for the SNWR diversion. The group did not wish to move the weir structure upstream without tying into a new fish screen structure that may not be built in the future.

Alternative 6 was abandoned once the deteriorating condition of the existing weir structure was confirmed. A major overhaul or rebuild of the weir structure is necessary and gives flexibility for placing a new fish ladder. The group also decided that an auxiliary water system was not desired due to the added operation and maintenance. The group believes that a new fish ladder with a well-placed entrance would provide good attraction to the new fish ladder.

Alternative 7 was abandoned once the deteriorating condition of the existing weir structure was confirmed. A major overhaul or rebuild of the weir structure is necessary and gives flexibility for placing a new fish ladder. The group also decided that an auxiliary water system was not desired due to the added operation and maintenance. The group believes that a new fish ladder with a well-placed entrance would provide good attraction to the new fish ladder. In addition, the group did not want to commit to building a new fish ladder with the intent of tying into a new fish screening facility that may not be built in the future.

Alternative 8 was abandoned once the deteriorating condition of the existing weir structure was confirmed. A major overhaul or rebuild of the weir structure is necessary and gives flexibility for placing a new fish ladder. The group also decided that an auxiliary water system was not desired due to the added operation and maintenance. The group believes that a new fish ladder with a well-placed entrance would provide good attraction to the new fish ladder.

Description of Investigation

ND staff began the preliminary engineering process with site surveys and hydrologic analyses. DFG and NMFS fish ladder design standards were referenced for determining design requirements for the alternatives investigated. A DFG fisheries biologist and DFG and NMFS engineers were consulted during the design phase. DWR geologists conducted a geologic investigation of the project site, and DWR environmental scientists conducted site evaluations.

Surveying and Site Information

Air targets were set in late June 2000 and surveyed with a Global Positioning System (GPS). The basis of survey control for the aerial photography was the North American Datum of 1983 (NAD 83), California State Plane, Zone 2 (feet) coordinates for the horizontal datum and the North American Vertical Datum of 1988 (NAVD 88), feet for the vertical datum. A continuous series of seven overlapping color aerial photos were taken of the EBC and Weir No. 2. A rectified photo mosaic of the reach was produced covering an area approximately 0.4 miles upstream and downstream of Weir No. 2. Figure 7 shows an area of that mosaic from the SNWR diversion about 900 feet upstream of Weir No. 2 to about 650 feet downstream of Weir No. 2.

DWR ND staff began topographic surveying at Weir No. 2 in July 2001. A total station and an automatic level were used to collect topographical data of the existing site. The topographical data included existing structures, ground shots, and cross sections in the EBC. A 1-foot contour map was created from this data. The existing staff gages used by DWR Sutter Maintenance Yard (SMY) staff are based on the United States Engineering Datum (USED). For this site, the NAVD 88 datum is 0.76 feet lower than the USED datum.

DWR ND staff made follow-up site visits after the initial survey. Trips were made to gather stage data in the EBC and to determine drill hole locations for the preliminary geologic investigation. Additional trips were made to DWR SMY for historical stage records, drawings, and operational procedures.

Site Hydrology

The available hydrology data for Weir No. 2 within the EBC are very limited (Figure 8). A staff gage located upstream of the weir and a newly installed (July 2001) downstream staff gage provide the only direct data at the site. Staff gages located upstream at Pumping Plant No. 3 and downstream at Pumping Plants No. 2 and No. 1 also provides some stage information. No discharge data exist for direct flows in the EBC.

The Butte Slough near Meridian gaging station is located upstream of the East-West Borrow Canals split. Unfortunately, the actual flow split is not recorded and varies

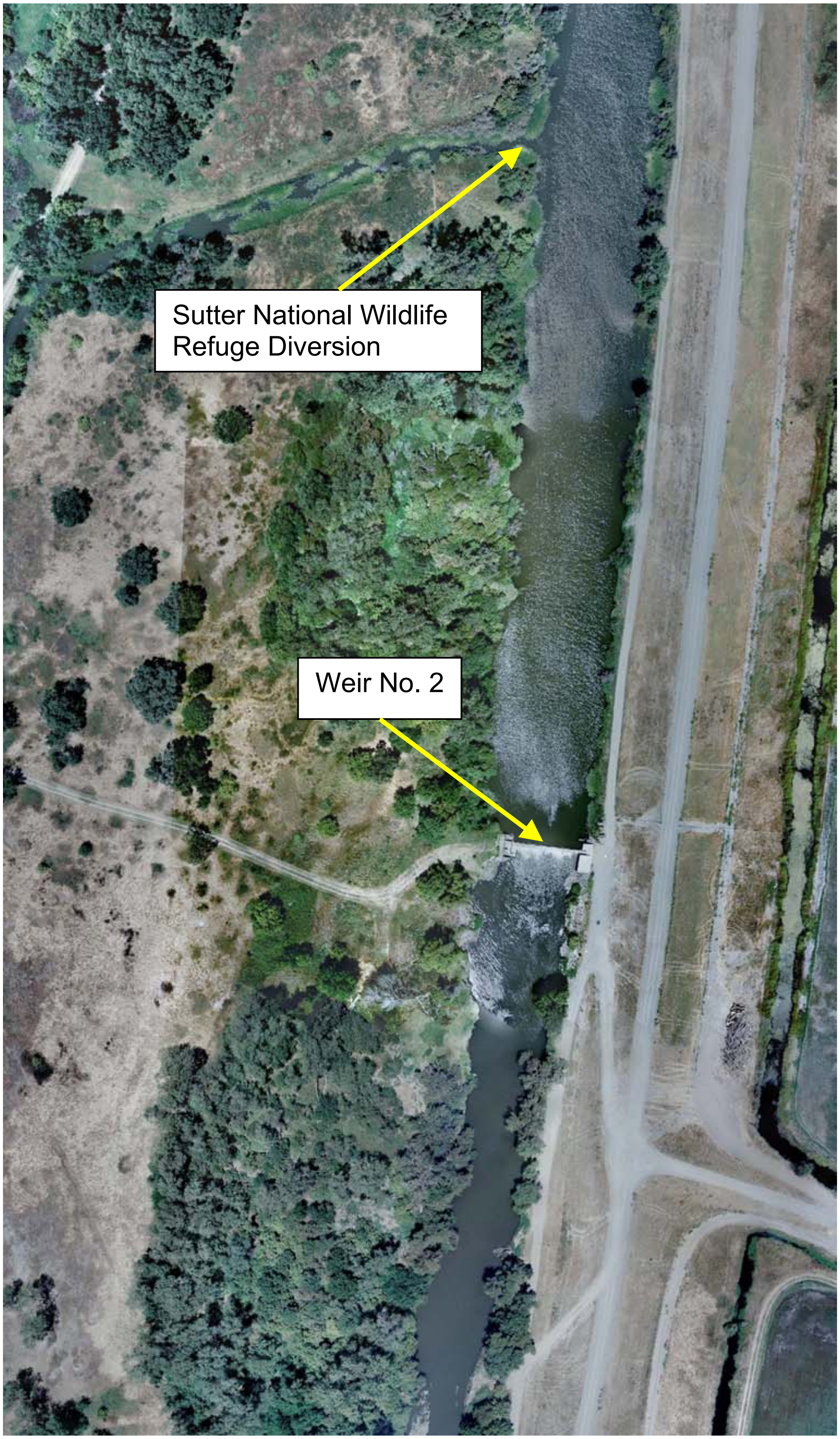


Figure 7. Aerial photograph of Weir No. 2

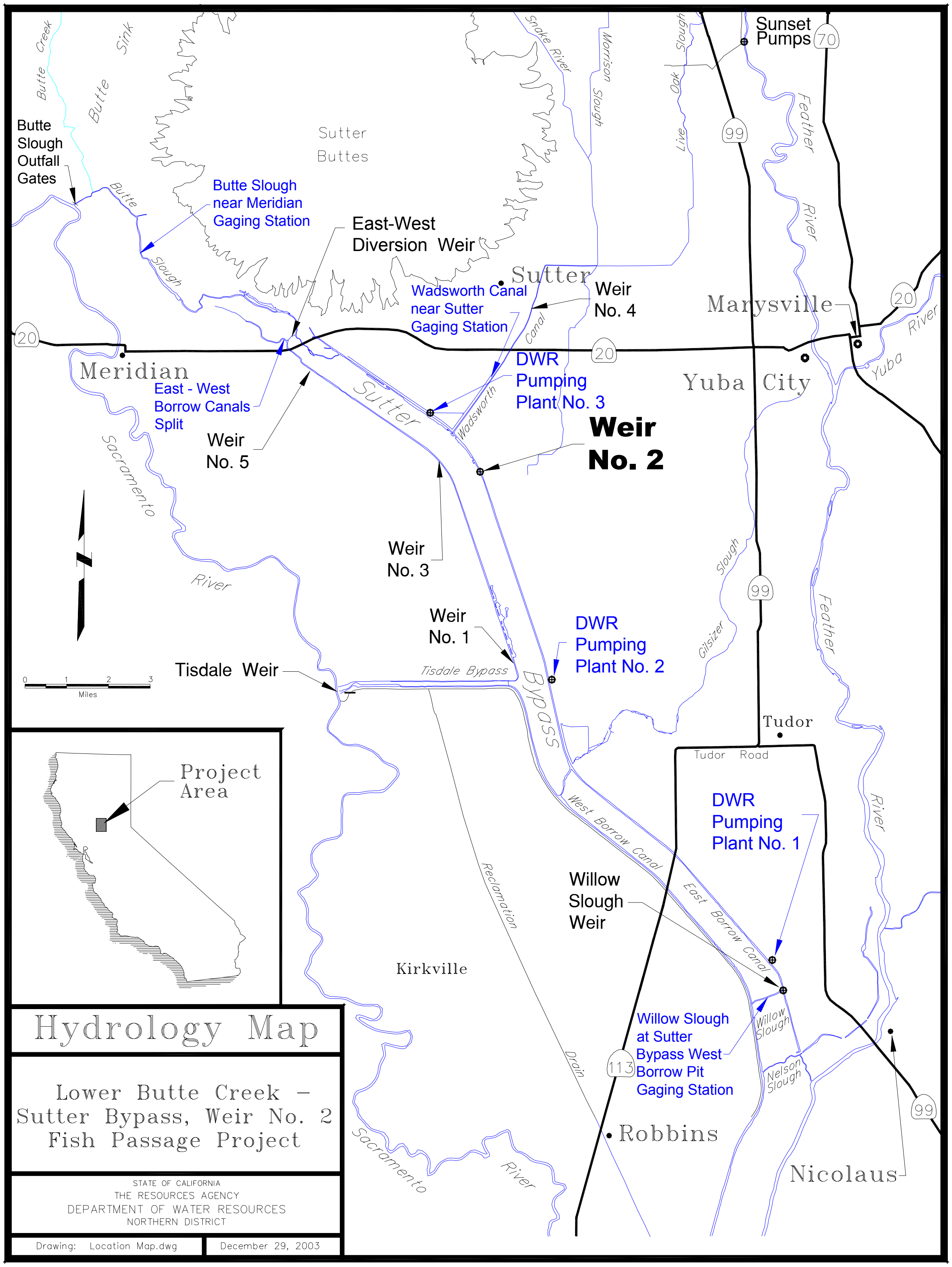


Figure 8. Hydrology map

during the year. Flow splits of 50% - 50% or 60% - 40% have been discussed or shown in print, but without an ability to measure or record flows, one can only guess as to what the flow split really is. In addition, the Sutter Bypass almost annually floods in the winter and inundates the East and West Borrow Canals. The Lower Butte Creek Project, Phase 1b Final Task Report (Task 5) estimates the out-of-bank flow for the upper EBC near the East-West Diversion weir to be approximately 1,040 cfs.

The Wadsworth Canal near Sutter gaging station was located upstream of Weir No. 2 and downstream of the East-West Borrow Canals split. The station recorded stage and flows of Wadsworth Canal into the EBC. This gage was decommissioned in 1996.

The Willow Slough at Sutter Bypass West Borrow Pit gaging station is located downstream of Weir No. 2 and the Willow Slough Weir. This station measures flow from the EBC to the WBC. Due to backwater effects from the WBC, the discharge records for the Willow Slough gage are not very accurate for flows above 400-500 cfs.

Because of the complexity of the Sutter Bypass system and the lack of discharge data, a consistent stage-discharge relationship cannot be made for Weir No. 2. Therefore, a typical 3-day delay design flow calculation cannot be made for a new fish ladder at Weir No. 2. To estimate a swim through condition past Weir No. 2 while meeting operational requirements, many scenarios and assumptions would need to be made such as: how many and which flashboards are in or out of the structure, the headwater stage above Weir No. 2, the tailwater stage of the EBC primarily controlled by the Willow Slough and Nelson Slough weirs, and discharge for the numerous diversions and inflows that exist within the EBC. The only constant in trying to determine a swim through condition is that a stage of 37.5 feet to 38.5 feet (USED) is required for upstream irrigators and habitat management for essentially the entire year. As flows increase in the EBC, DWR SMY staff removes flashboards row by row to maintain the required water surface elevation. Based on this typical operating practice, a swim through condition would be very difficult because even at flows up to approximately 1,200 cfs, a 4-foot or larger head differential would likely exist. As flows approach and exceed 1,200 cfs, DWR SMY staff will likely remove all the flashboards providing a swim through condition for fish passage. As long as the operational stage can be maintained, the existing fish ladder provides some fish passage, even though increased flows will begin to drown out the entrance. Once the operational stage cannot be maintained, flashboards must be removed and a swim through condition will exist.

Site Geology

DWR-DOE Project Geology staff performed geologic exploration to collect specific subsurface geological data to be used in the final design of the foundations for the new weir and fish ladder. The exploration work consisted of 2 auger holes drilled to a depth of 60 feet on each side of the existing weir structure (Figure 8). Soil classification and Standard Penetration Test blow-counts were recorded during the exploration work. Soil samples were collected at 5-foot increments at each of the auger holes for potential lab testing. Appendix D contains the memorandum summarizing the results of the geologic exploration work.

A previous geologic exploration investigation by DWR-DOE Project Geology staff was conducted for the site in 1986. The exact location of the exploration borings are not known, but are believed to be about 100 feet downstream of the existing Weir No. 2 structure. This information is also included in the memorandum in Appendix D.

Figure 9. Auger drilling on the west bank of Weir No. 2

Environmental Review

DWR environmental scientists performed site surveys of the project area to identify potential environmental issues. The environmental survey consisted of field surveys to investigate potential impacts to sensitive plants, fish, wildlife, aesthetics, water quality, recreation, and land use. No threatened or endangered plant species were identified within the project area. Appendix E contains a list of potentially required environmental permits and a preliminary environmental checklist for the proposed project.

Structural Evaluation

During the topographic survey in July 2001, DWR ND staff discovered a large hole in the apron on the downstream side of the Weir No. 2 structure in the third bay from the west bank. The hole was not visible due to the apron being submerged. The hole became apparent when the survey crew was recording elevations of the apron and discovered a void where the elevation was much lower than the surrounding apron. The hole was estimated to be about 5 to 6 feet deep and 1 to 2 feet in diameter. The finding was reported to DWR SMY staff. This caused concern because the void in the foundation of the existing weir structure is becoming large enough to extend to the piers of the structure which will ultimately result in failure of Weir No. 2.

Another reason for concern was that a current meter measurement (CMM) performed immediately downstream of Weir No. 2 and a weir calculation performed at the same time on July 10, 2001, resulted in a discrepancy of about 40%. The CMM was 125 cfs compared to the weir flow of 76 cfs. The 49 cfs of unaccounted for water past the weir structure is not likely to occur strictly through the flashboards. It is thus assumed that the difference between the actual measurement and weir flow plus flashboard leakage is the water leaking under the Weir No. 2 foundation. A second CMM and weir flow calculation was conducted on August 14, 2002, and resulted in a discrepancy of 18% (165 cfs CMM/136 cfs weir flow), or 29 cfs, which is not likely to occur strictly through the flashboards. The leakage occurring under the Weir No. 2 foundation could lead to more undermining and ultimately failing.

An evaluation of the structure by the DWR-DOE, Structure Section was requested in August 2002. In September 2002, Weir No. 2 was partially dewatered by DWR SMY staff (Figure 9). This allowed an evaluation to assess the condition of the existing structure (Figure 10). The structural evaluation concluded that significant wear has occurred to the concrete apron of the structure. The concrete apron is worn to the point that three holes exist exposing the underlying soil. A hole exists in the downstream cutoff wall along with an adjacent void, indicating seepage is eroding the soil directly below the apron. Appendix C contains the memorandum summarizing the results of the Weir No. 2 structural evaluation.

Figure 10. Weir No. 2 dewatering

Figure 11. Evaluating the downstream apron

Summary of Findings

Comparison of Viable Alternatives

Alternative 3a – Half Ice Harbor fish ladder with new weir. Cost Estimate $ 3,504,000

- Remove the existing right bank pool and weir fish ladder.
- Remove the existing weir structure including the foundation and abutments.
- Construct a new weir structure at the same location, reducing the number of bays by incorporating 3 large automated spillway gates into the structure along with smaller bulkhead and flashboard bays.
- Construct a new half Ice Harbor fish ladder on the left bank tied into the new weir structure.
- Construct a small control building for the controls of the automated spillway gate.
- Run overhead power to the site.

Alternative 3b - Full Ice Harbor fish ladder with new weir. Cost Estimate $ 3,728,000

- Remove the existing right bank pool and weir fish ladder.
- Remove the existing weir structure including the foundation and abutments.
- Construct a new weir structure at the same location, reducing the number of bays by incorporating 3 large automated spillway gates into the structure along with smaller bulkhead and flashboard bays.
- Construct a new full Ice Harbor fish ladder on the left bank tied into the new weir structure.
- Construct a small control building for the controls of the automated spillway gate.
- Run overhead power to the site.

Alternative 3c - Vertical slot fish ladder with new weir. Cost Estimate $ 3,551,000

- Remove the existing right bank pool and weir fish ladder.
- Remove the existing weir structure including the foundation and abutments.
- Construct a new weir structure at the same location, reducing the number of bays by incorporating 3 large automated spillway gates into the structure along with smaller bulkhead and flashboard bays.
- Construct a new vertical slot fish ladder on the left bank tied into the new weir structure.
- Construct a small control building for the controls of the automated spillway gate.
- Run overhead power to the site.

Advantages and Disadvantages

As mentioned previously, Alternative 3 was the option carried through the preliminary design process. Three sub-alternatives were developed, each with a different type of fish ladder. Alternative 3a is a half Ice Harbor, alternative 3b is a full Ice Harbor, and Alternative 3c is a vertical slot (Figure 12).

The proposed new weir structure is identical for all three of the fish ladder sub-alternatives. The three fish ladder sub-alternatives would all be incorporated into the left abutment of the new weir structure.

The advantage of Alternative 3a is that the 29 cfs half Ice Harbor fish ladder would be a big improvement for fish passage compared to the existing pool and weir ladder. The half Ice Harbor fish ladder meets current fish ladder standards, improves attraction with increased flow and provides a better orientation to the new weir structure. The half Ice Harbor fish ladder allows fish to pass Weir No. 2 by either jumping over a set of weirs or swimming through the set of orifices. The half Ice Harbor fish ladder is capable of operating at flows as low as 5 cfs. Additionally, Alternative 3a is slightly less expensive than Alternative 3b and Alternative 3c.

There is little disadvantage with Alternative 3a other than the lower baffles would typically be submerged. Based on average tailwater elevations observed, it is expected that the lower three baffles will be submerged. These lower three baffles are necessary because the fish ladder was designed to operate under the lowest tailwater condition observed. Submergence of the lower three baffles is likely to result in a slight increase in sediment accumulation in these pools, due to lower velocities. An additional entrance at the turning pool between baffles 3 and 4 provides an alternate entrance for fish (Sheet 4).

The 58 cfs full Ice Harbor fish ladder of Alternative 3b has the same advantages as Alternative 3a. In addition, it has twice the flow capacity as the half Ice Harbor fish ladder. The full Ice Harbor fish ladder allows passage past Weir No. 2 by jumping over one of the two sets of weirs or swimming through one of the two sets of orifices (Sheet 4 and Sheet 5). The full Ice Harbor fish ladder is capable of operating at flows as low as 5 cfs.

Alternative 3b has the same disadvantage of submerged baffles as Alternative 3a. In addition, Alternative 3b is slightly higher in cost than Alternative 3a and Alternative 3c.

The advantage of the 55 cfs vertical slot fish ladder in Alternative 3c is the ability to self regulate flows through the fish ladder (assuming that proper adjustments are made at the entrance). The vertical slot fish ladder would also meet current standards and have improved attraction characteristics like Alternatives 3a and 3b. Additionally, Alternative 3c is slightly less expensive than Alternative 3b.

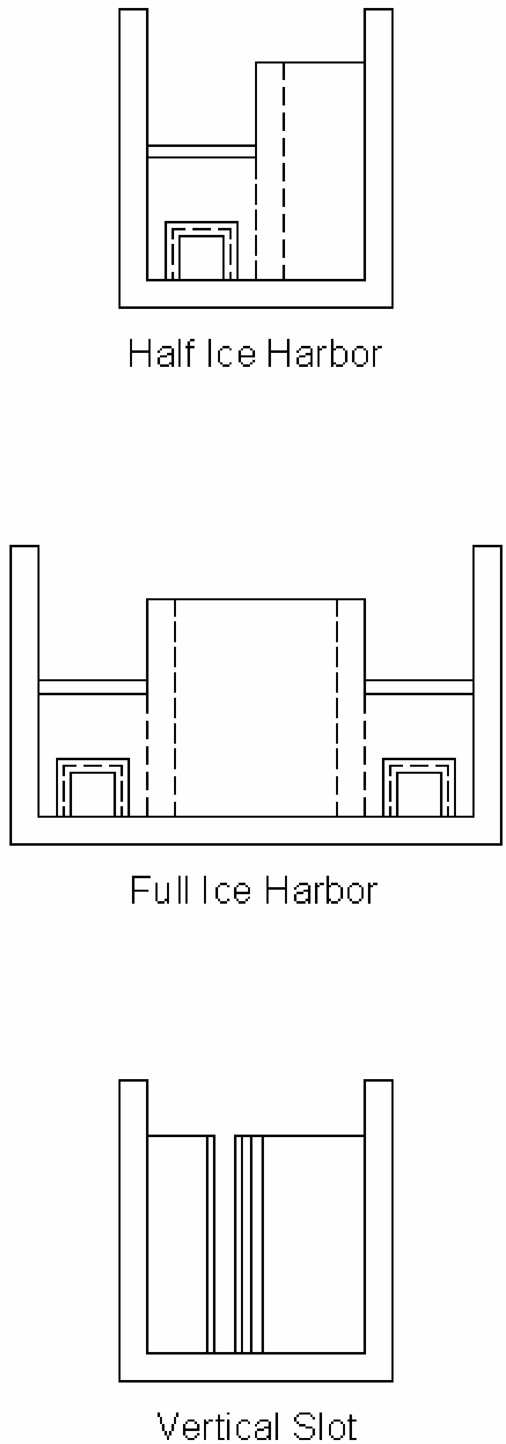


Figure 12. Fish ladder alternatives

Alternative 3c has the same disadvantage of submerged baffles as Alternatives 3a and 3b. The vertical slot fish ladder can also be prone to debris accumulation through the single passage slot. The vertical slot fish ladder also has a minimum flow capacity of about 27 cfs based on the recommended 3-foot minimum depth requirement, which would not meet the minimum flow requirement of 5 cfs that DWR was asked to design for.

Conclusions and Recommendations

The stakeholder group decided Alternative 3b, constructing a new weir and full Ice Harbor fish ladder, is the preferred alternative. Replacement or major repairs of the existing weir structure is required since the structural analysis confirmed the deteriorated condition of the foundation. It was decided that replacement of the structure would be more economical because the existing foundation would need to be completely replaced. Rebuilding the structure provides flexibility to incorporate features that will enhance fish passage, improve operations, and reduce maintenance, such as the addition of automated spillway gates. The full Ice Harbor fish ladder will increase fish passage over a greater range of flows, include four separate routes for passage, and provide an improved entrance for attracting fish.

Full Ice Harbor Fish Ladder

Fish Ladder Sizing and Configuration

The full Ice Harbor fish ladder design has a flow capacity of 58 cfs and includes two 4-foot wide rectangular weirs and two 20-inch square orifices in each baffle. Twelve baffles are included in the fish ladder to allow passage past Weir No. 2. Each pool has internal dimensions of 16 feet in width by 10 feet in length. A turning pool exists between baffles 9 and 10 to allow the fish ladder entrance to be positioned near the weir structure (Sheet 8). Water flows into the exit pool of the fish ladder through a 4-foot wide slot oriented perpendicular to the EBC flow, which can be controlled with flashboards if necessary. The fish ladder entrance pool contains one 18-inch and one 24-inch wide slot controlled with flashboards. A third 24-inch wide entrance slot for the fish ladder exists in the turning pool in the chamfered wall angled toward the EBC (Sheet 4). This third entrance slot can be used when the lower baffles of the fish ladder are submerged.

Based on tailwater elevations observed at the site for the last two years, and historical data at DWR Pumping Plant 2 located approximately 6 miles downstream of Weir No. 2, it is anticipated that the lower three baffles will be submerged during normal irrigation season flows. The fish ladder was designed so that fish passage can be maintained during occasional low flow conditions that have occurred in the past.

Fish Ladder Operation and Maintenance

Access to the site for operation and maintenance exists with the new fish ladder located on the east bank. Existing roads along the Sutter Bypass and down to the project site allow vehicles to be driven adjacent to the fish ladder. For safety, the entire fish ladder will be covered with a skid-proof working platform that will be designed to be removable for access to the fish ladder.

The primary maintenance for the full Ice Harbor fish ladder will be to clean the trashrack at the flow entrance of the fish ladder to prevent debris accumulation. The fish ladder could be closed off seasonally when fish passage is not required to allow removal of gravel and sediments that may have accumulated in the pools. When seasonal flooding does occur, the handrails should be removed so they are not damaged by debris. Once flows recede, the handrails should be replaced, and debris will need to be removed from the working platform covering the entire fish ladder.

The primary operational requirement for the fish ladder will be to ensure that proper adjustment of the entrance is maintained to ensure good fish passage conditions. The head difference between the entrance pool and the water surface in the EBC should be no more than 1 foot. The automated spillway gates will be set to maintain a consistent upstream stage of 38.5 feet USED (37.74 feet NAVD 88), which should minimize the need for adjustments at the flow entrance of the fish ladder. The land side weir of the two uppermost baffles (Sheet 5) are adjustable to allow the fish ladder to still operate if the stage upstream of Weir No. 2 drops below the normal operating stage mentioned above. The right weir in the first baffle will be designed so that it can be lowered 2 feet and the right weir in the second baffle will be designed so it can be lowered 1 foot. This adjustment will be accomplished with the use of 4-foot wide flashboards.

It is anticipated that the ability to maintain the normal operating stage above Weir No. 2 would only be lost during extreme low flow conditions. If flows get low enough that adequate depth cannot be maintained in the pools, then one set or both sets of orifices can be closed off with stop gates. The fish ladder would then be operated strictly as a pool and weir fishway. The construction of a new weir structure will result in a much more watertight structure that will allow sufficient stage to be maintained behind it and ensure flow into the fish ladder at all times.

Replacement Weir

Location

Various locations for constructing a new weir were considered during the investigation. One option investigated was to tie the new fish ladder into a new fish screen for the SNWR. Placing the new structure upstream near the SNWR diversion was rejected by the stakeholder group because screening of the diversion may not be needed. Placing the structure 100 feet downstream of the existing structure was also considered with the idea that the existing structure could be left in place to protect the new weir structure and act as a trashrack. DWR had considered replacing the weir in the 1980s at this location. Due to the condition of the existing weir structure foundation and the likelihood of the structure failing without repair, it was decided to not pursue this option. It was agreed that removing the existing weir structure and rebuilding at the same location was preferred (Sheet 3). Rebuilding at the same location will reduce the environmental impacts and help streamline the permitting process.

Features Considered

The decision to rebuild the Weir No. 2 structure allowed the group to consider various options to incorporate into the new structure. One goal of rebuilding the new structure was to reduce the tedious and cumbersome task of removing and placing flashboards to maintain the required stage upstream of Weir No. 2 during the irrigation season. In addition, DWR SMY staff are required to remove more than 100 flashboards to allow flows to pass the structure when the Sutter Bypass floods. There is usually a short window of time for doing this because diversions typically continue until the Sutter Bypass begins to flood. Once floodflows recede, the flashboards eventually need to be reset so diversions can begin again. During the winter of 2003, DWR SMY staff were required to repeat this process twice when late rains caused the Sutter Bypass to flood a second time after flows had receded. Automating the operation and reducing the number of piers to help reduce the debris load were other features considered for a new weir structure.

An exact replacement of the existing Weir No. 2 structure was considered and was determined to be a less costly alternative. A direct replacement would not reduce the number of piers because flashboards larger than 5 or 6 feet are undesirable due to their weight. In addition, the annual routine of removing or replacing a large amount of flashboards would still occur. Concerns about the safety of this type of operation were also a concern to members of the group. The group decided to eliminate this type of structure from consideration.

In the 1980s, DWR had considered incorporating a constant upstream level gate into a new weir structure that would automatically control about 500 cfs of releases during the diversion season. The gate would either be submerged or need to be removed annually. Leaving the gate submerged would make it prone to damage from debris and require additional maintenance due to prolonged submergence during floods. Removing the gate annually would require a heavy-duty crane to be brought on site, and a large truck would be necessary to transport the gate to the DWR SMY for storage. The remaining structure would still be made up of bays that would need to be manually operated with flashboards and bulkheads. The group decided to eliminate this type of gate from consideration.

An automated spillway gate was also considered for incorporation into the new weir structure. This type of gate would allow the number of piers to be reduced because of the size of the gate panel. The spillway gate is not susceptible to damage from high flows and doesn't need to be removed annually since the gate panel will lay down, thus allowing floodflows to pass over it. The gate is essentially operated as a flow over weir and not like a radial arm or slide gate that releases flow from the bottom of the gate. The ability of the automated spillway gate to maintain a desired stage will result in a very reliable flow into the new fish ladder. The group decided that a new weir structure with automated spillway gates was the preferred option.

Spillway Gate System

The automated spillway gate proposed for the new Weir No. 2 structure is composed of square steel gate panels, reinforced air bladders, and a control system that relies on air pressure to adjust the steel gate panel (Sheet 7). The reinforced air bladder is the mechanism that raises and lowers the steel gate panel. The steel gate panel would be anchored and hinged into a new concrete foundation. The gate panel would have a slight arc to it that will allow the air bladder to be stored beneath it when it is deflated to lower the gate during flood flows (Figure 13). The air bladder is made of durable rubber that contains Kevlar and is resistant to wear, weathering, and punctures. The control system uses compressed air to adjust the pressure in the air bladder, which controls the height of the gate panel. The control system will be set to automatically maintain a specific water surface upstream. A manual control will also be included as part of the system.

Figure 13. Installation of spillway gates

It was decided that three 12 foot wide by 12.75 foot high spillway gates would be incorporated into the new weir structure. Three spillway gates will allow higher flows to pass without creating a backwater effect when the EBC reaches bankfull conditions. The spillway gates will also allow a more reliable swim through condition to exist when the upstream stage begins to exceed the normal operating stage for diversions and the new fish ladder. Spillway gates can be adjusted so that fish passage exists either through the fish ladder or with a swim through condition past Weir No. 2. This is a huge advantage over the existing flashboard weir structure since DWR SMY staff are limited to removing boards row by row.

Since there are no means to dewater Weir No. 2 in the EBC, the new structure will need to be constructed so periodic maintenance can be performed on the spillway gates. Piers will be constructed between the three spillway gates and the bays on both sides of the gates. This will provide an ability to isolate, repair, or replace a gate panel or air bladder by placing bulkheads at the upstream and downstream ends of the piers. These rare occurrences would require the use of a crane for installing and removing the bulkheads.

Manual Bays

In addition to the three spillway gates discussed above, the new Weir No. 2 structure will also include six 5½-foot wide bays that will contain bulkheads and some flashboards. The upper 4 to 5 feet will have flashboards that can be manually placed or removed. The lower portion of each manual bay will consist of removable metal bulkheads. Three bays will exist on both sides of the spillway gates, next to the newly constructed left and right abutments.

Operation and Maintenance

A key feature of the automated spillway gates is the ability to set them to maintain a constant stage of 38.5 feet USED (37.74 feet NAVD 88) during the irrigation season. The other key feature of these gates is the ability to manually lower the gates by deflating the air bladders to lay the gates down and pass higher flows when the Sutter Bypass floods. When flows recede and the stage needs to be maintained for upstream water diversions, the air bladders are inflated to raise the spillway gates to the desired height. If needed, manual adjustments of spill over the weir structure can be made by placing or removing flashboards or bulkheads in the six manual bays. Flashboards are sized so they can be handled manually by DWR SMY personnel. The bulkheads would be sized so that equipment such as a boom truck or crane would be utilized to remove or install them. Each bulkhead would be no more than 7,500 pounds, but actual sizes and weights will be determined in final design. During the wet season, there may not be vehicle access on the west bank. The maximum distance for lifting a bulkhead would be 55 feet from the edge of the east abutment to the center of the farthest spillway gate bulkheads if the west bank is flooded. Heavy equipment access to the east abutment will be provided across a portion of the new fish ladder.

Weir No. 2 Design and Construction Summary

Site Conditions and Assumptions

The preliminary drawings and layouts contained in this report will be refined during the final design process. Additional surveys, hydraulic analyses, and geologic exploration may be necessary because of changes in the site conditions since this investigation was conducted or to gain additional information that will be required for final design.

Codes and Standards

Final Designs will be governed by the following criteria:

- Final structural designs will comply with the latest Uniform Building Code requirements.
- Final concrete designs will comply with the latest American Concrete Institute Building Code Requirements for Reinforced Concrete Design.
- All current applicable CalOSHA safety standards will be met.
- All environmental permit conditions will be met.

Final Design Instructions

Final designs will adhere to the following directives:

- An operations and maintenance manual should be made available prior to project completion.
- The elevations shown in the drawings for Weir No. 2 are based on the NAVD 88 Datum. Descriptions and elevations of control points can be obtained from ND.
- Actual concrete thickness, foundation and cutoff wall requirements, and reinforcement requirements will be determined by the final design engineer.

Special Project Notes

The estimated quantities and costs shown in Tables 1, 2, and 3 and the preliminary engineering drawings are not intended for bidding or construction purposes, as final designs may result in changes to any or all quantities and costs. Final designs will be subject to the approval of the California Department of Fish and Game (DFG), National Marine Fisheries Service (NMFS), United States Fish and Wildlife Service (USFWS), the Reclamation Board, and DWR.

The Weir No. 2 Fish Passage Project is located within a FEMA Zone A designated special flood hazard area, within a low flow channel of the Sutter Bypass. The Sutter Bypass floods frequently and overtopping of Weir No. 2 is a common occurrence. The replacement of Weir No. 2 and construction of a new fish ladder within the low flow channel is not expected to raise the 100 year base flood elevation within the Sutter Bypass. This must be verified in final design and the provisions of Chapter

44, Section 65.3 of the National Flood Insurance Program’s Code of Federal Regulations must be met.

Construction Summary

At the Weir No. 2 site, no improvements to the existing access roads are proposed. Staging areas would exist on the west and east sides of the EBC. Access to the site exists for both banks of the project site. The west access would be from Hughes Road and require travel through a portion of the SNWR on existing roads to Weir No. 2. The east access would be from Acacia or McClatchy Road, to the Eastern Sutter Bypass levee, and down an existing maintenance road to Weir No. 2.

Staging areas would be available on both sides of the EBC. The west side staging area should avoid the existing riparian areas along the banks and should not interfere with the SNWR. The east side staging area would likely exist from the toe of the east side of the Sutter Bypass levee to the toe drains that exists on the north and south sides of McClatchy Road (Sheet 3). Staging areas should be clearly delineated prior to the start of construction.

Temporary sheet piles, cofferdams, flumes, pipes, and pumps may be used in the project area for dewatering purposes. To ensure a longer construction window, dewatering efforts should ensure that adequate fish passage is provided during construction. This may require sheet piling only half of the EBC and project site at a time to ensure fish passage.

Maintaining an adequate upstream stage for diversions will also be required during the construction project. Construction of a temporary side channel is a possibility for dewatering, but would likely present difficulties for providing adequate fish passage during construction. Approximately 10 feet of head could be present which would result in high velocities in a side channel if temporary baffles are not provided. The need to maintain an adequate upstream stage during construction will require that a headworks structure be a part of the side channel diversion.

Removal of the existing Weir No. 2 structure and fish ladder is required. Based on the routine operation of flashboard removal to allow floodflows to pass, no buildup of materials exists behind Weir No. 2 at the time of the investigation. Concrete and steel that is excavated in the project area should be hauled to a disposal site subject to approval by DWR.

Table 1. Preliminary Cost Estimate - Half Ice Harbor Fish Ladder

Lower Butte Creek - Sutter Bypass, Weir No. 2 Fish Passage Project
Preliminary Cost Estimate for Design & Construction

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
	MISCELLANEOUS				
1	Mobilization/Demobilization	1	LS	$ 75,000	$ 75,000
2	Site Work, Access, & Mitigation	1	LS	$ 30,000	$ 30,000
3	Dewatering (Sheet Piling)	1	LS	$ 300,000	$ 300,000
4	Remove Existing Concrete	875	CY	$ 150	$ 131,000
5	Overhead Power	2640	FT	$ 25	$ 66,000
					$ 602,000
	FISH LADDER - Half Ice Harbor				
6	Excavation	300	CY	$ 50	$ 15,000
7	Keying, Drilling & Doweling	1	LS	$ 25,000	$ 25,000
8	Stop Gates	24	EA	$ 300	$ 7,000
9	Concrete (Walls)	175	CY	$ 800	$ 140,000
10	Concrete (Baffles)	25	CY	$ 800	$ 20,000
11	Concrete (Slab & Footings)	80	CY	$ 500	$ 40,000
12	Flashboards - 2' and 4'	1	LS	$ 1,000	$ 1,000
13	Working Platform (3' wide)	1000	SF	$ 25	$ 25,000
14	Drivable Platform	1	LS	$ 40,000	$ 40,000
					$ 313,000
	WEIR w/3 Spillway Gates				
15	Excavation	300	CY	$ 50	$ 15,000
16	Concrete (Piers)	85	CY	$ 800	$ 68,000
17	Concrete (Slab & Footings)	260	CY	$ 500	$ 130,000
18	Sheet Piling (Cutoff Wall)	2100	SF	$ 26	$ 55,000
19	Concrete (Abutments)	140	CY	$ 800	$ 112,000
20	Working Platform	450	SF	$ 50	$ 23,000
21	Bulkheads (Manual Bays)	1	LS	$ 25,000	$ 25,000
22	Bulkheads (Spillway Gate Bay)	1	LS	$ 70,000	$ 70,000
23	Flashboards - 1' x 6'	1	LS	$ 1,000	$ 1,000
24	Spillway Gates (3)	1	LS	$ 328,000	$ 328,000
25	Air Supply and Control System	1	LS	$ 39,000	$ 39,000
26	Installation of Gate and Control System	1	LS	$ 92,000	$ 92,000
27	Rip Rap	100	TN	$ 50	$ 5,000
28	Control Building	80	SF	$ 200	$ 16,000
					$ 979,000
29	**Construction Cost**				**$ 1,894,000**
30	**Contingency @ 25%**				$ 474,000
31	**Construction Cost Subtotal**				**$ 2,368,000**
32	**Engineering @ 25%**				$ 592,000
33	**Environmental @ 3%**				$ 71,000
34	**Construction Inspection @ 15%**				$ 355,000
35	**Contract Administration @ 5%**				$ 118,000
36	**Total**				**$ 3,504,000**

Table 2. Preliminary Cost Estimate - Full Ice Harbor Fish Ladder

Lower Butte Creek - Sutter Bypass, Weir No. 2 Fish Passage Project
Preliminary Cost Estimate for Design & Construction

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
	MISCELLANEOUS				
1	Mobilization/Demobilization	1	LS	$ 75,000	$ 75,000
2	Site Work, Access, & Mitigation	1	LS	$ 30,000	$ 30,000
3	Dewatering (Sheet Piling)	1	LS	$ 300,000	$ 300,000
4	Remove Existing Concrete	875	CY	$ 150	$ 131,000
5	Overhead Power	2640	FT	$ 25	$ 66,000
					$ 602,000
	FISH LADDER - Full Ice Harbor				
6	Excavation	400	CY	$ 50	$ 20,000
7	Keying, Drilling & Doweling	1	LS	$ 25,000	$ 25,000
8	Stop Gates	24	EA	$ 300	$ 7,000
9	Concrete (Walls)	200	CY	$ 800	$ 160,000
10	Concrete (Baffles)	50	CY	$ 800	$ 40,000
11	Concrete (Slab & Footings)	150	CY	$ 500	$ 75,000
12	Flashboards - 2' and 4'	1	LS	$ 1,000	$ 1,000
13	Working Platform (3' wide)	2600	SF	$ 25	$ 65,000
14	Drivable Platform	1	LS	$ 40,000	$ 40,000
					$ 433,000
	WEIR w/3 Spillway Gates				
15	Excavation	300	CY	$ 50	$ 15,000
16	Concrete (Piers)	85	CY	$ 800	$ 68,000
17	Concrete (Slab & Footings)	260	CY	$ 500	$ 130,000
18	Sheet Piling (Cutoff Wall)	2100	SF	$ 26	$ 55,000
19	Concrete (Abutments)	140	CY	$ 800	$ 112,000
20	Working Platform	450	SF	$ 50	$ 23,000
21	Bulkheads (Manual Bays)	1	LS	$ 25,000	$ 25,000
22	Bulkheads (Spillway Gate Bay)	1	LS	$ 70,000	$ 70,000
23	Flashboards - 1' x 6'	1	LS	$ 1,000	$ 1,000
24	Spillway Gates (3)	1	LS	$ 328,000	$ 328,000
25	Air Supply and Control System	1	LS	$ 39,000	$ 39,000
26	Installation of Gate and Control System	1	LS	$ 92,000	$ 92,000
27	Rip Rap	100	TN	$ 50	$ 5,000
28	Control Building	80	SF	$ 200	$ 16,000
					$ 979,000
29	**Construction Cost**				**$ 2,014,000**
30	**Contingency @ 25%**				$ 504,000
31	**Construction Cost Subtotal**				**$ 2,518,000**
32	**Engineering @ 25%**				$ 630,000
33	**Environmental @ 3%**				$ 76,000
34	**Construction Inspection @ 15%**				$ 378,000
35	**Contract Administration @ 5%**				$ 126,000
36	**Total**				**$ 3,728,000**

Table 3. Preliminary Cost Estimate - Vertical Slot Fish Ladder

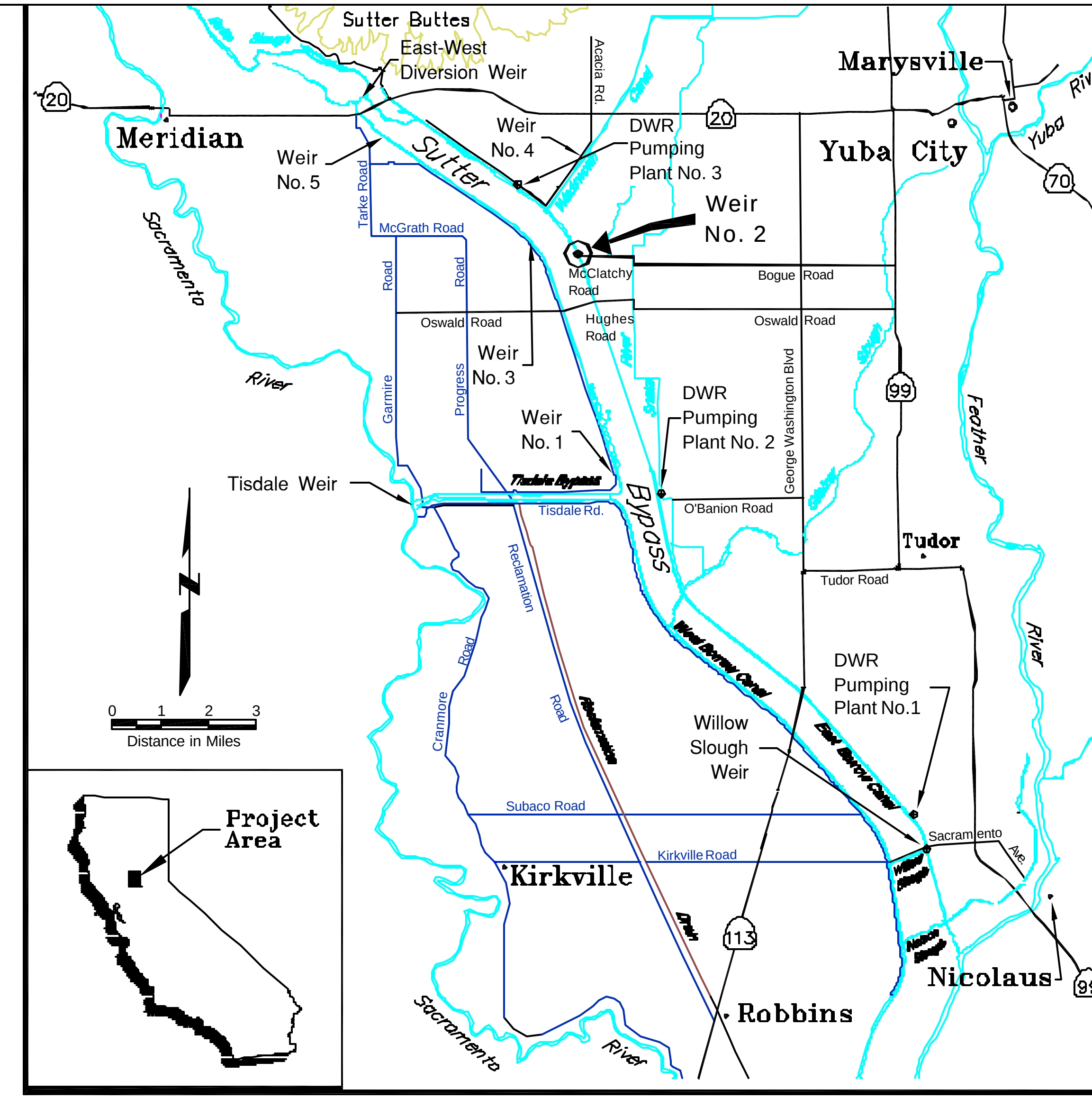
Lower Butte Creek - Sutter Bypass, Weir No. 2 Fish Passage Project
Preliminary Cost Estimate for Design & Construction

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
	MISCELLANEOUS				
1	Mobilization/Demobilization	1	LS	$ 75,000	$ 75,000
2	Site Work, Access, & Mitigation	1	LS	$ 30,000	$ 30,000
3	Dewatering (Sheet Piling)	1	LS	$ 300,000	$ 300,000
4	Remove Existing Concrete	875	CY	$ 150	$ 131,000
5	Overhead Power	2640	FT	$ 25	$ 66,000
					$ 602,000
	FISH LADDER - Vertical Slot				
6	Excavation	300	CY	$ 50	$ 15,000
7	Keying, Drilling & Doweling	1	LS	$ 25,000	$ 25,000
8	Stop Gates	24	EA	$ 300	$ 7,000
9	Concrete (Walls)	190	CY	$ 800	$ 152,000
10	Concrete (Baffles)	25	CY	$ 800	$ 20,000
11	Concrete (Slab & Footings)	100	CY	$ 500	$ 50,000
12	Flashboards - 2' and 4'	1	LS	$ 1,000	$ 1,000
13	Working Platform (3' wide)	1100	SF	$ 25	$ 28,000
14	Drivable Platform	1	LS	$ 40,000	$ 40,000
					$ 338,000
	WEIR w/3 Spillway Gates				
15	Excavation	300	CY	$ 50	$ 15,000
16	Concrete (Piers)	85	CY	$ 800	$ 68,000
17	Concrete (Slab & Footings)	260	CY	$ 500	$ 130,000
18	Sheet Piling (Cutoff Wall)	2100	SF	$ 26	$ 55,000
19	Concrete (Abutments)	140	CY	$ 800	$ 112,000
20	Working Platform	450	SF	$ 50	$ 23,000
21	Bulkheads (Manual Bays)	1	LS	$ 25,000	$ 25,000
22	Bulkheads (Spillway Gate Bay)	1	LS	$ 70,000	$ 70,000
23	Flashboards - 1' x 6'	1	LS	$ 1,000	$ 1,000
24	Spillway Gates (3)	1	LS	$ 328,000	$ 328,000
25	Air Supply and Control System	1	LS	$ 39,000	$ 39,000
26	Installation of Gate and Control System	1	LS	$ 92,000	$ 92,000
27	Rip Rap	100	TN	$ 50	$ 5,000
28	Control Building	80	SF	$ 200	$ 16,000
					$ 979,000
29	**Construction Cost**				**$ 1,919,000**
30	**Contingency @ 25%**				$ 480,000
31	**Construction Cost Subtotal**				**$ 2,399,000**
32	**Engineering @ 25%**				$ 600,000
33	**Environmental @ 3%**				$ 72,000
34	**Construction Inspection @ 15%**				$ 360,000
35	**Contract Administration @ 5%**				$ 120,000
36	**Total**				**$ 3,551,000**

PRELIMINARY ENGINEERING DRAWINGS FOR

LOWER BUTTE CREEK
SUTTER BYPASS
WEIR NO. 2
FISH PASSAGE PROJECT

SUTTER COUNTY, CALIFORNIA

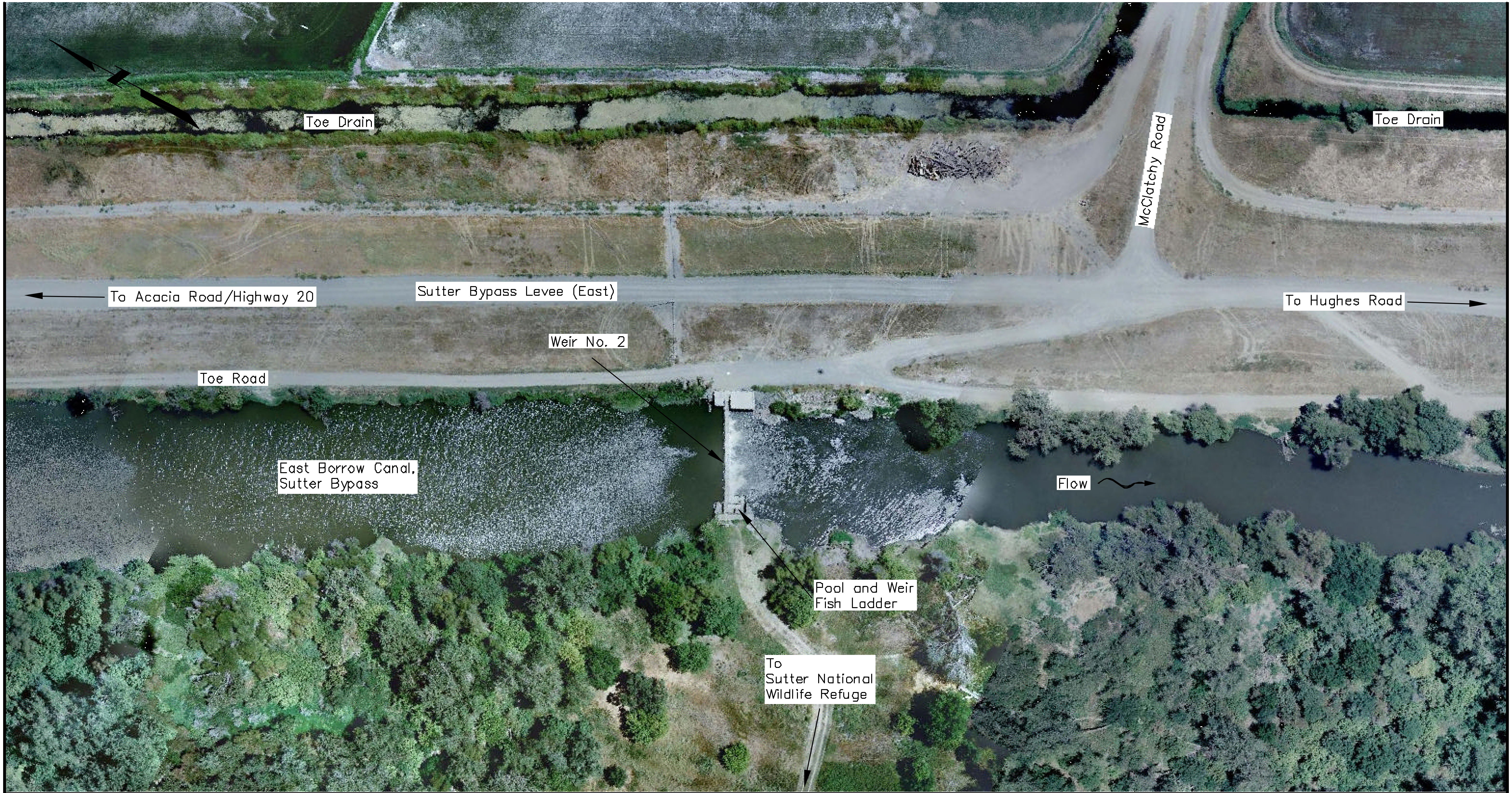


INDEX OF SHEETS

PRELIMINARY SUBJECT TO REVISION

Note: All Proposed Work Denoted in Upper Case Text on Following Sheets.

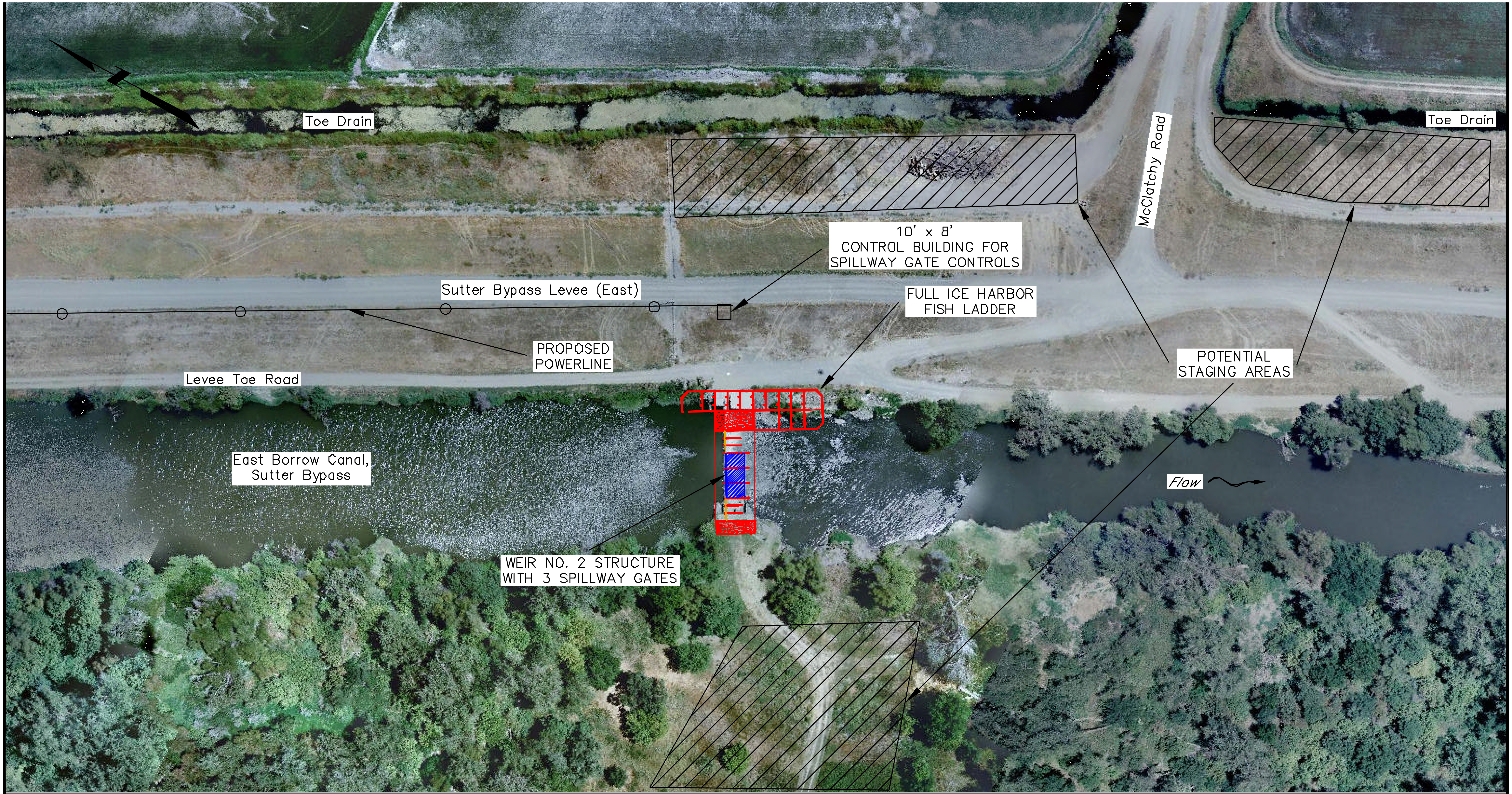
Weir No. 2 Near Yuba City, California	Title Sheet and Area Map	STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES NORTHERN DISTRICT Revision Date: December 10, 2003	Drawing: Title.dwg Sheet 1 of 9



Notes:
1. Aerial photograph taken June 30, 2000

80 0 80 160
Scale in Feet

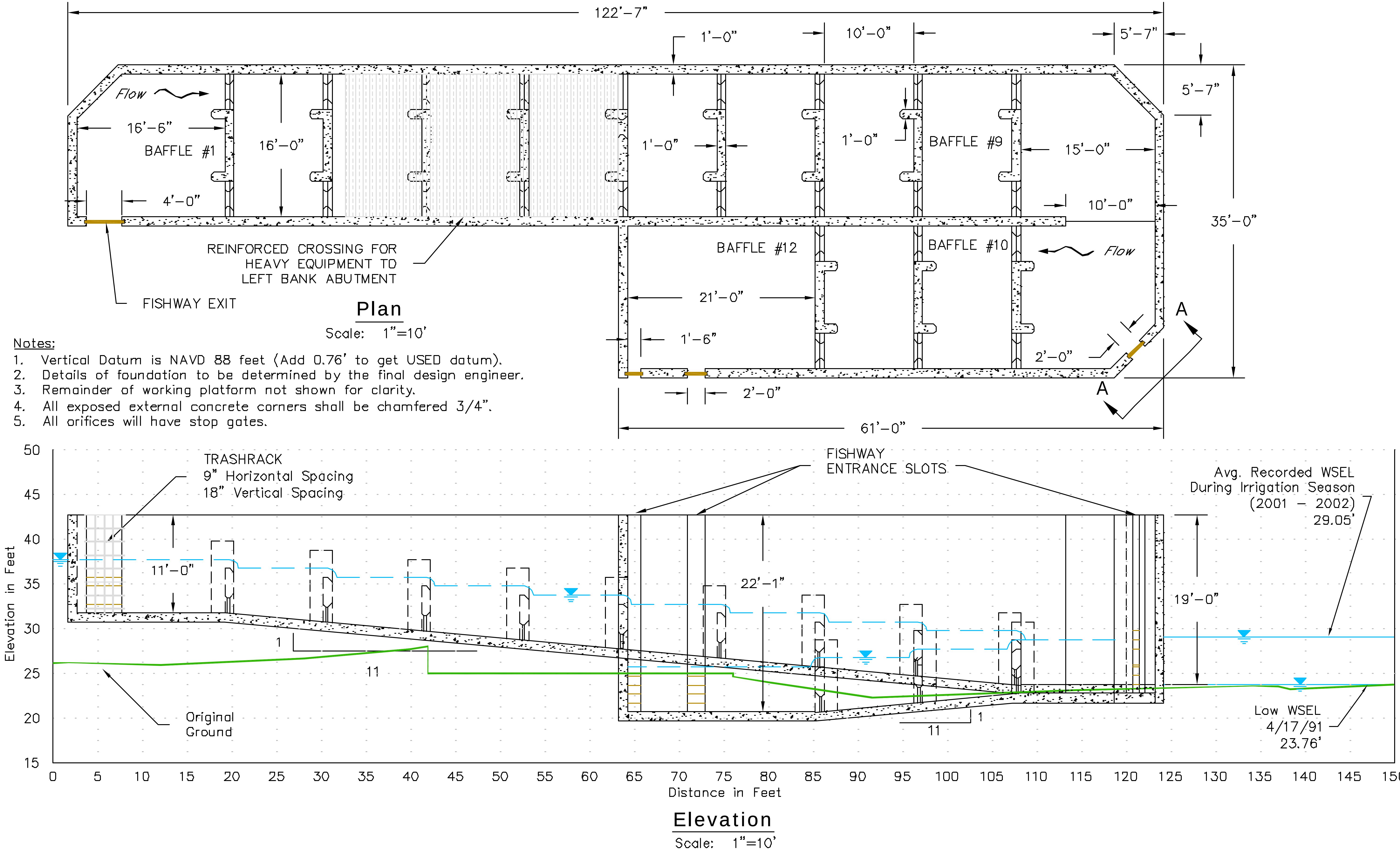
Weir No. 2 Near Yuba City, California	General Plan	STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES NORTHERN DISTRICT	Drawing: Weir2_topo.dwg
		Revision Date: August 6, 2003	Sheet 2 of 9



Notes:
1. Aerial photograph taken June 30, 2000

80 0 80 160
Scale in Feet

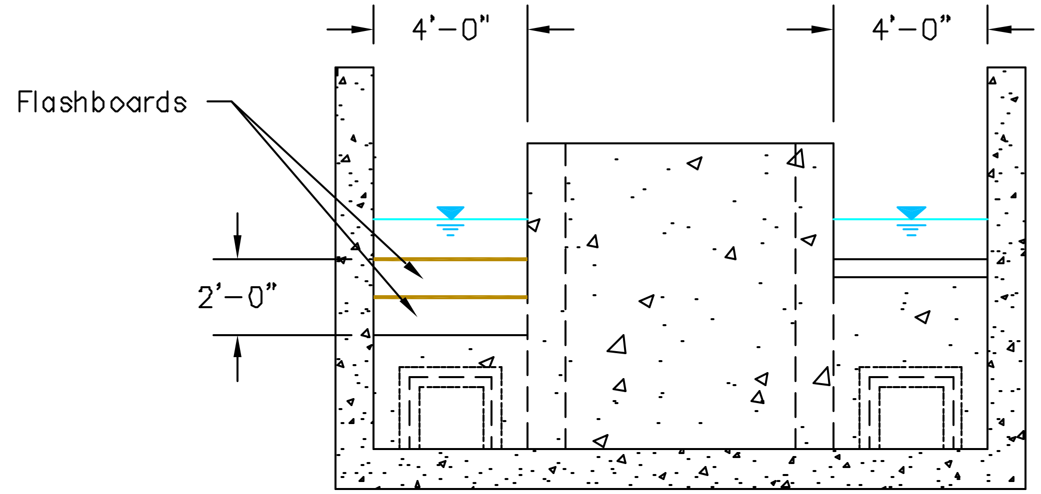
Weir No. 2 Near Yuba City, California	Site Plan	STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES NORTHERN DISTRICT	Drawing: Weir2_topo.dwg
		Revision Date: December 16, 2003	Sheet 3 of 9



Notes:

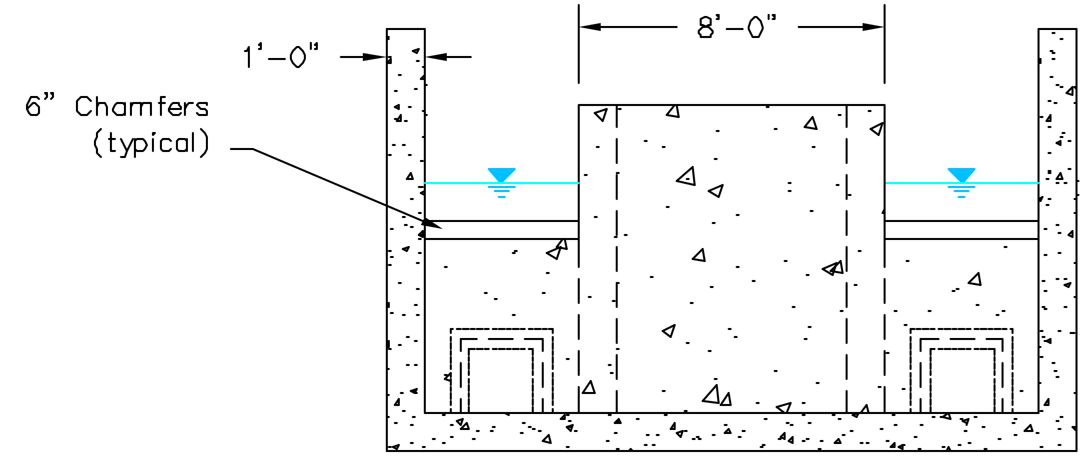
1. Vertical Datum is NAVD 88 feet (Add 0.76' to get USED datum).
2. Details of foundation to be determined by the final design engineer.
3. Remainder of working platform not shown for clarity.
4. All exposed external concrete corners shall be chamfered 3/4".
5. All orifices will have stop gates.

Weir No. 2 Near Yuba City, California	Full Ice Harbor Fish Ladder Plan and Elevation	STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES NORTHERN DISTRICT Revision Date: September 23, 2003	Drawing: Full Ice Harbor.dwg Sheet 4 of 9



Baffle #1

Scale: 1"=5'



Baffles #3 - #12

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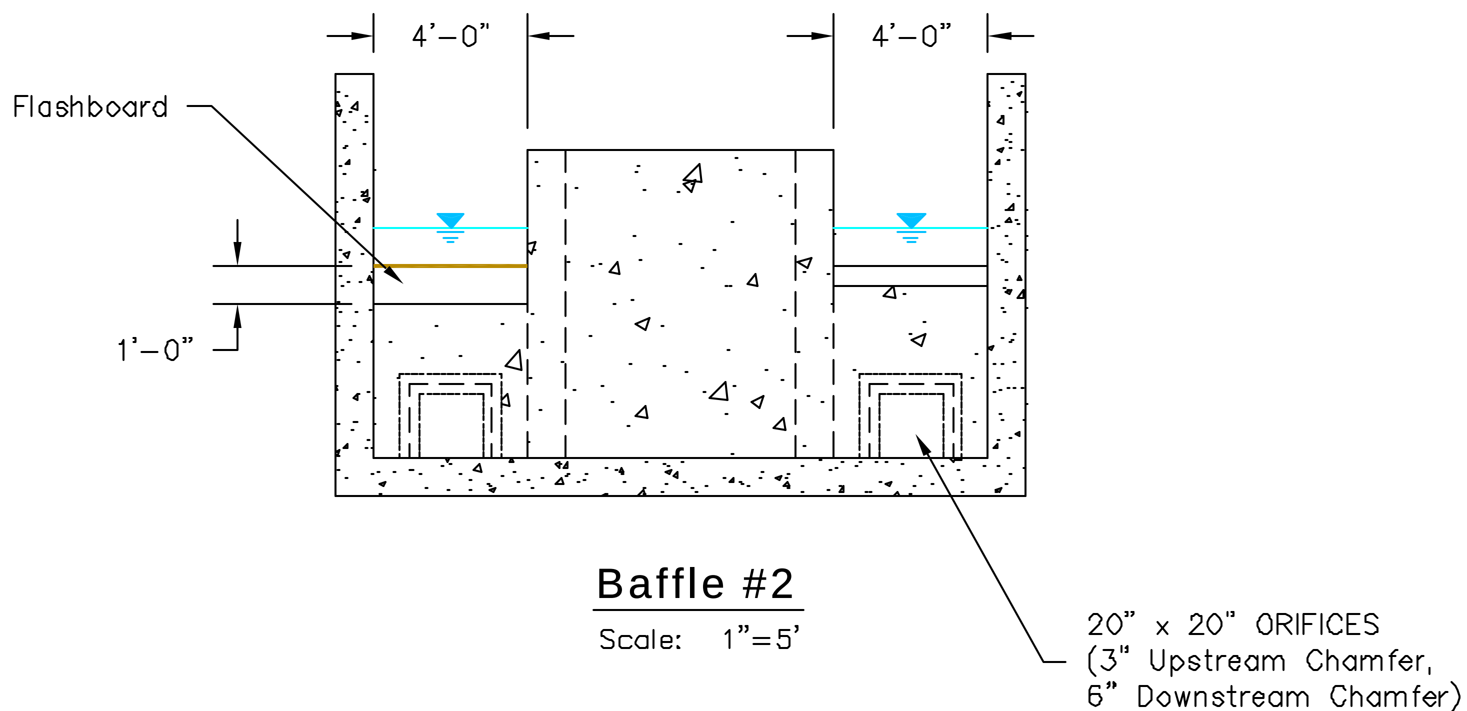
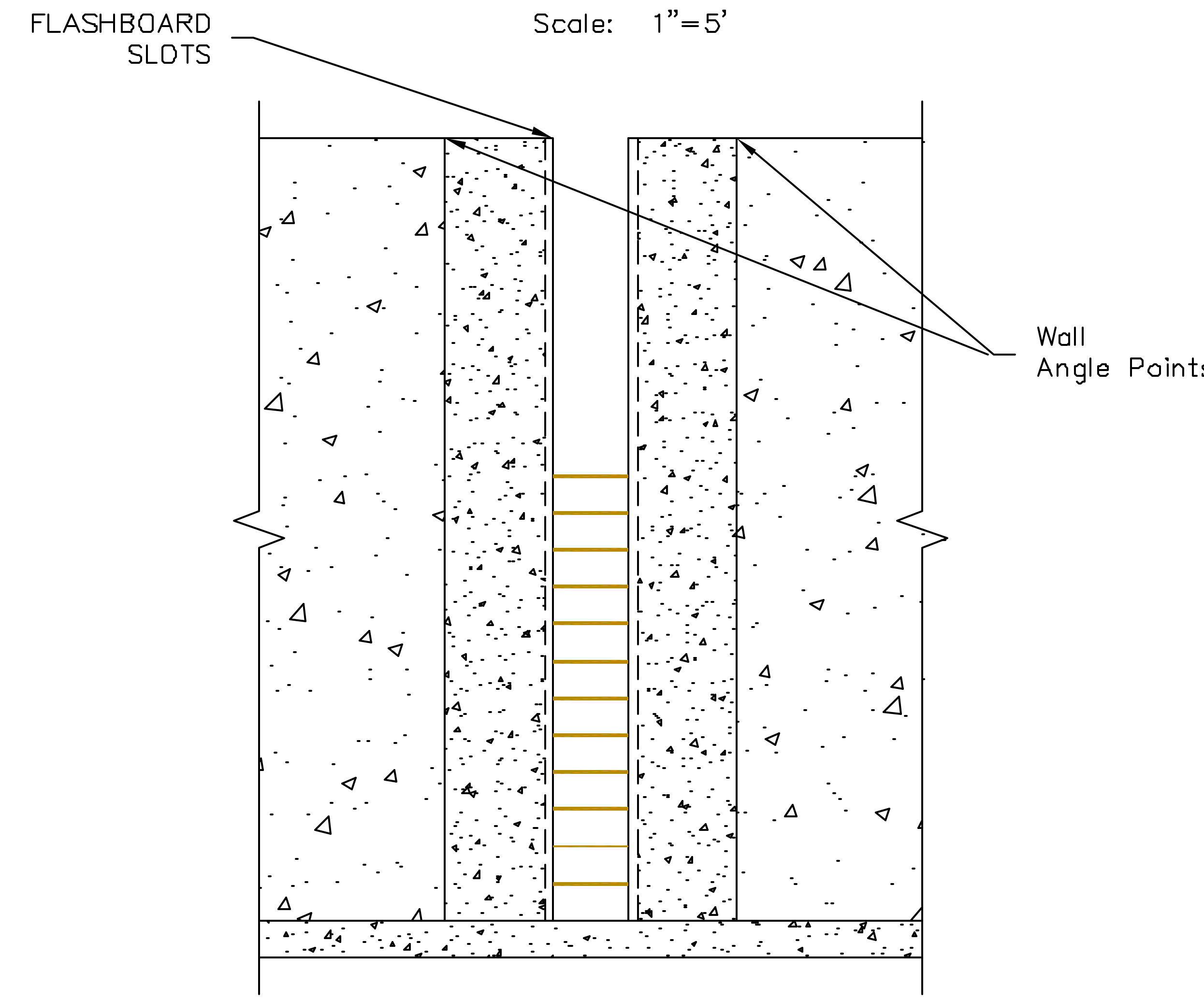


Baffle #2

Scale: 1"=5'



Section A-A

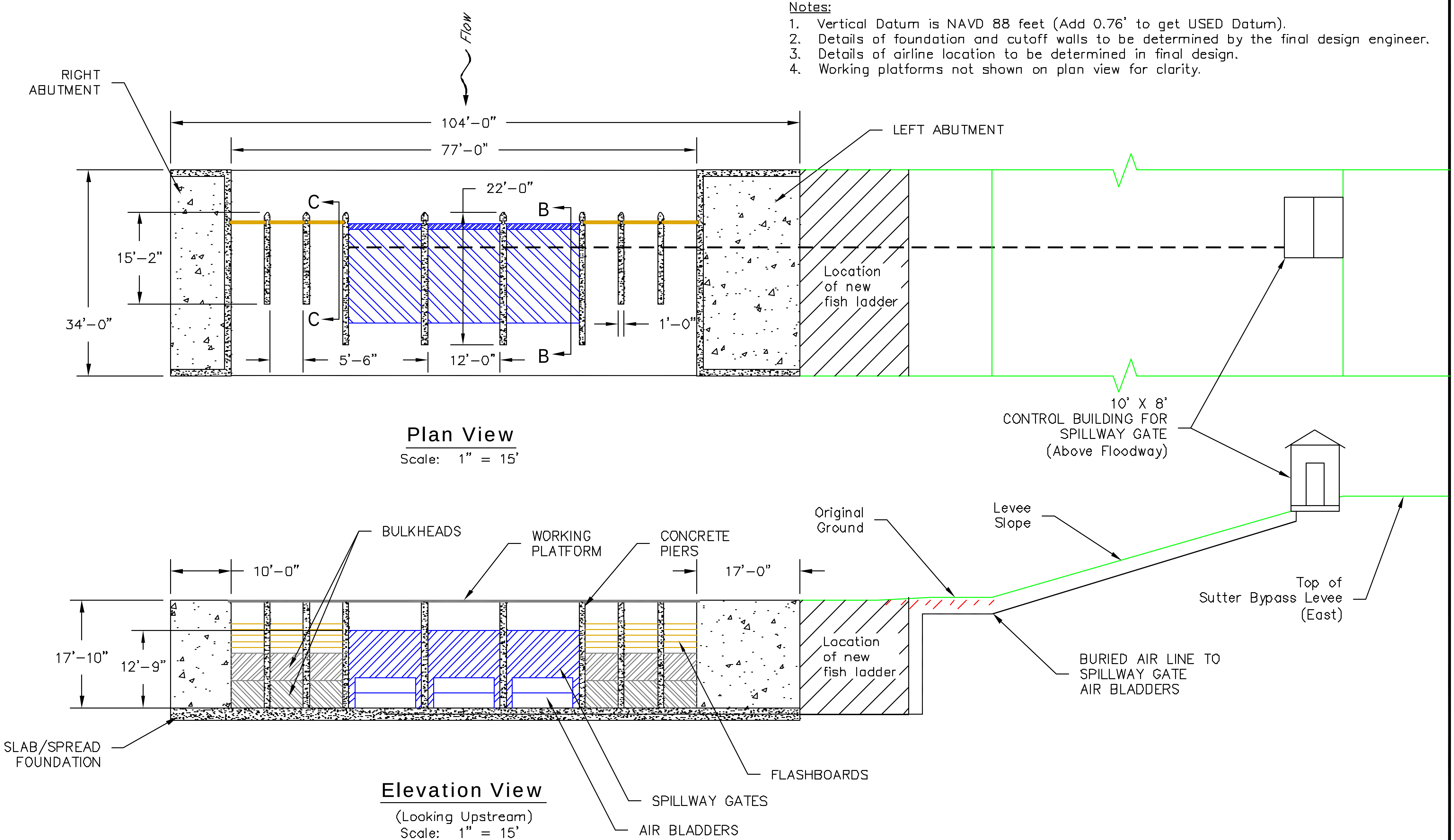
Scale: 1"=5'

Notes:
1. Details of the foundation shall be determined by the final design engineer.
2. All external concrete corners shall be chamfered 3/4".
3. All orifices shall have stop gates.
4. Working platforms not shown.
5. Baffles are shown from the downstream side, looking upstream.

Weir No. 2 Near Yuba City, California	Full Ice Harbor Fish Ladder Details	State of California The Resources Agency Department of Water Resources Northern District	Drawing: Full Ice Harbor Details.dwg
		Revision Date: September 15, 2003	Sheet 5 of 9

Notes:

1. Vertical Datum is NAVD 88 feet (Add 0.76' to get USED Datum).
2. Details of foundation and cutoff walls to be determined by the final design engineer.
3. Details of airline location to be determined in final design.
4. Working platforms not shown on plan view for clarity.



Plan View

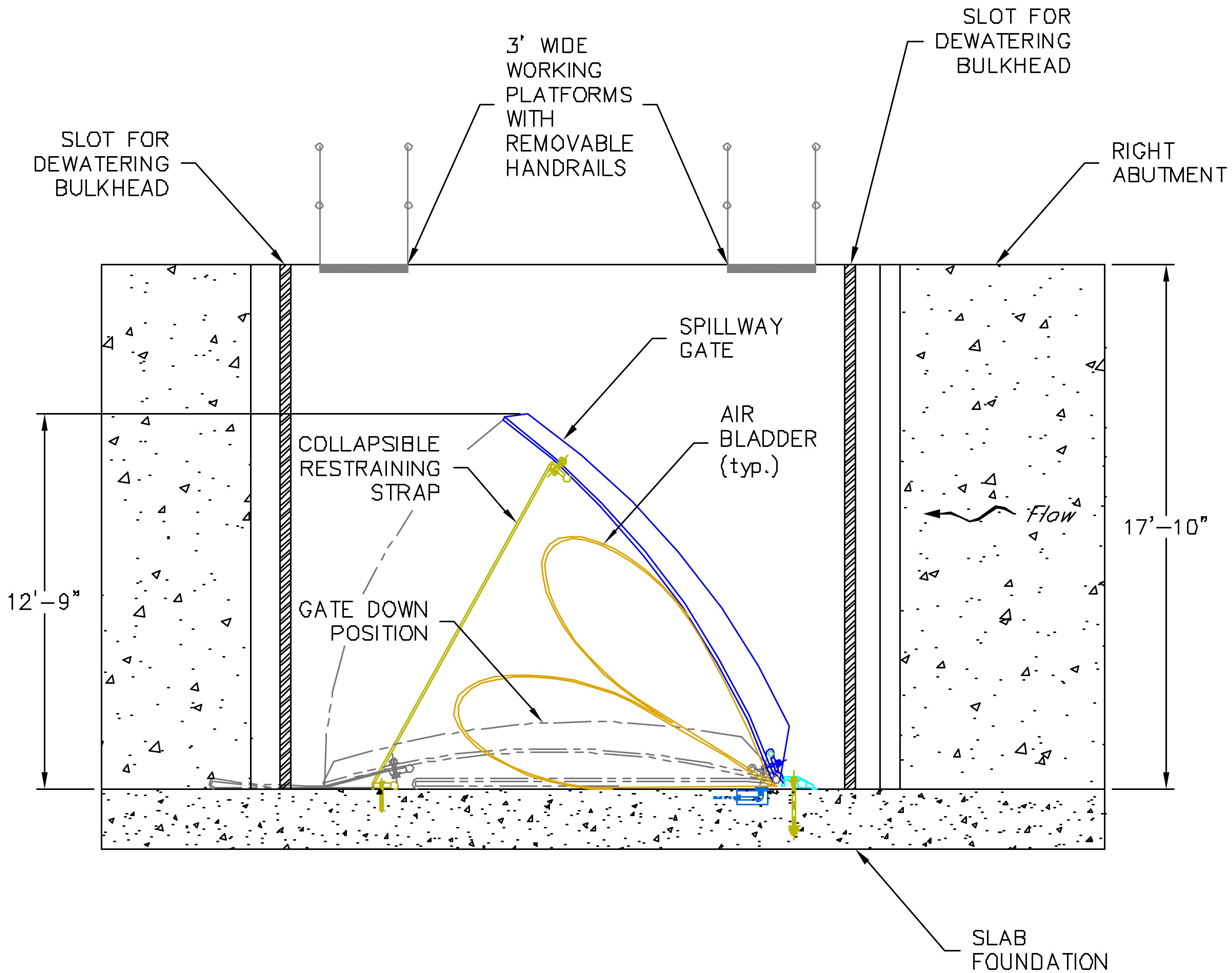
Scale: 1" = 15'

Elevation View

(Looking Upstream)

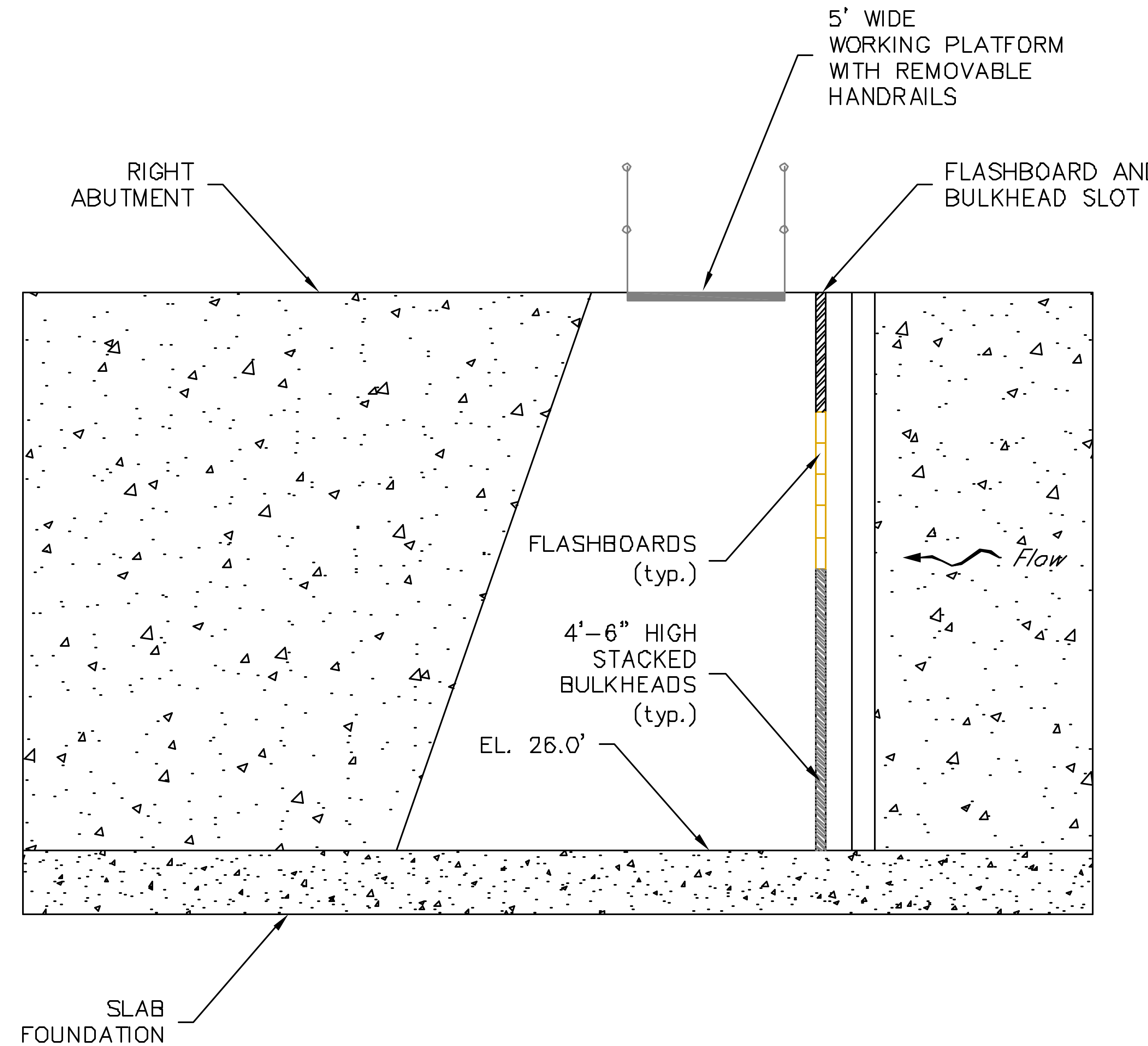
Scale: 1" = 15'

Weir No. 2 Near Yuba City, California	Weir No. 2 Plan and Elevation	STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES NORTHERN DISTRICT Revision Date: December 10, 2003	Drawing: Weir with 3 Gates Sheet 6 of 9



Section B-B

Scale: 1" = 5'

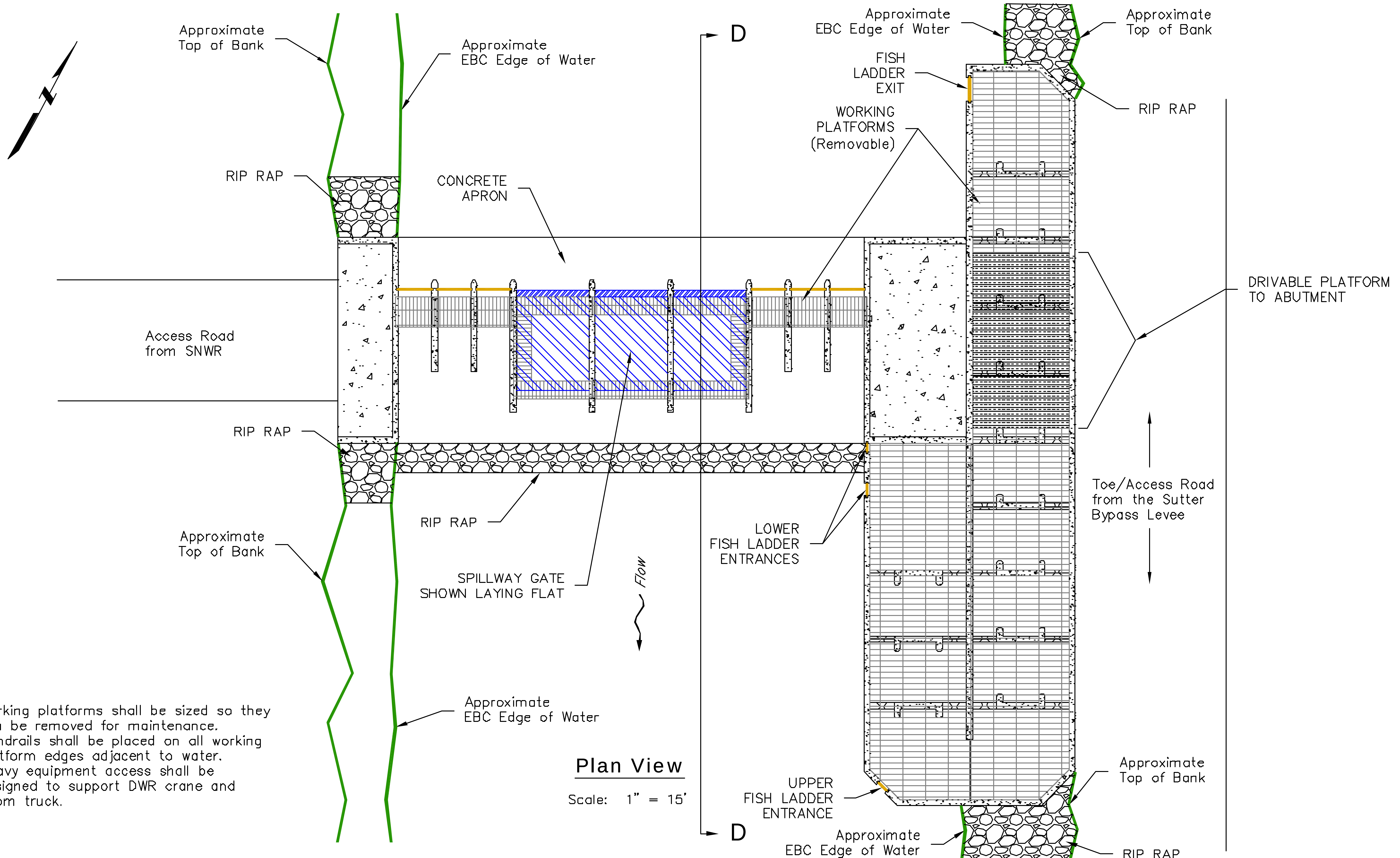


Section C-C

Scale: 1" = 5'

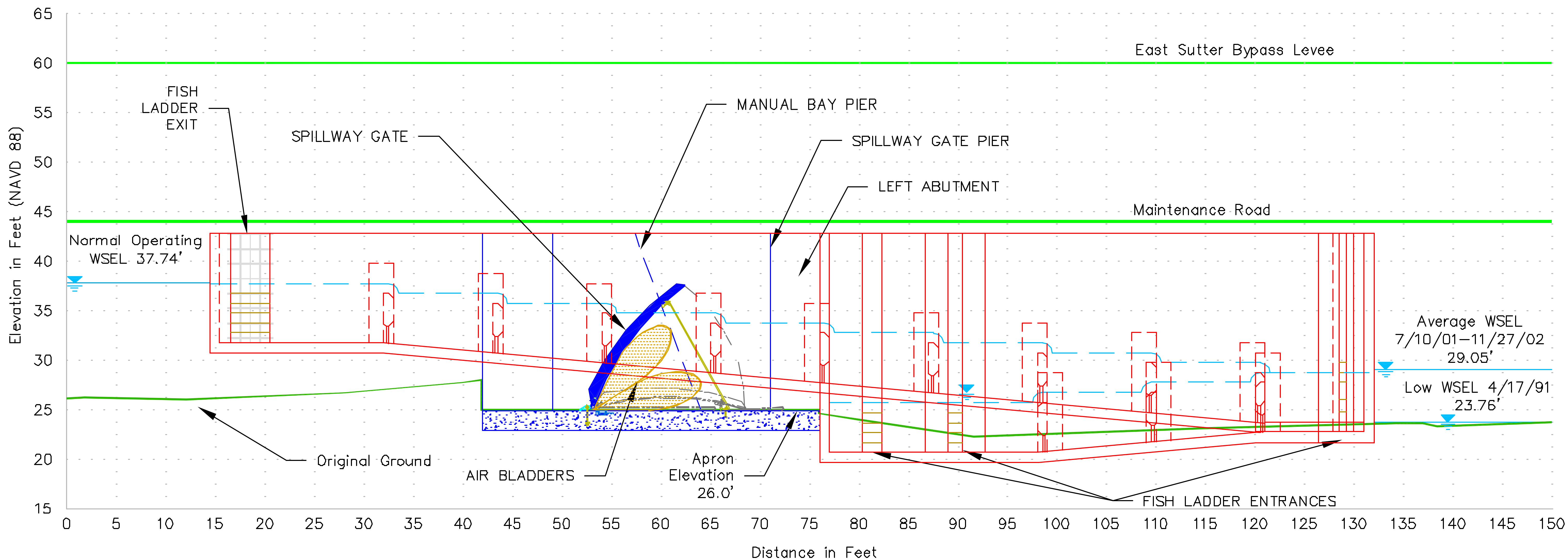
Notes:
1. Vertical Datum is NAVD 88 feet (Add 0.76' to get USED Datum).
2. Working Platform not shown.
3. Details of foundation and cutoff walls to be determined by the final design engineer.

Weir No. 2 Near Yuba City, California	Weir No. 2 Weir and Gate Details	STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES NORTHERN DISTRICT Revision Date: September 15, 2003	Drawing: MOD_weir_and_gate_details.dwg Sheet 7 of 9



Notes:
1. Working platforms shall be sized so they can be removed for maintenance.
2. Handrails shall be placed on all working platform edges adjacent to water.
3. Heavy equipment access shall be designed to support DWR crane and boom truck.

Weir No. 2 Near Yuba City, California	Weir No. 2 and Fish Ladder Plan	STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES NORTHERN DISTRICT	Drawing: Weir with Ladder Plan.dwg
		Revision Date: September 23, 2003	Sheet 8 of 9



SECTION D-D

(Looking East)

Scale: 1" = 10'

Notes:

1. Vertical Datum is NAVD 88 feet (Add 0.76' to get USED Datum).

Weir No. 2 Near Yuba City, California	Weir No. 2 and Fish Ladder Section	STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES NORTHERN DISTRICT Revision Date: September 23, 2003	Drawing: Weir with Ladder Profile.dwg Sheet 9 of 9

Appendix A Table of Contents

Lower Butte Creek - Sutter Bypass, Weir No. 2 Fish Passage Project
May 30, 2002 Meeting at Sutter Maintenance Yard
Meeting Summary

Attendees:

Olen Zirkle, Ducks Unlimited
Kevin Foerster, USFWS - Sacramento NWRC
Mike Peters, USFWS - Sacramento NWRC
Dale Garrison, USFWS - CVPIA
Steve Thomas, NMFS
Paul Ward, CDFG
Paul Russell, Sutter Extension Water District (SEWD)
Keith Swanson, DWR - Division of Flood Management (DWR-DFM)
Michelle Ng, DWR - Division of Flood Management
Ken Dickerson, DWR - DFM, Sutter Maintenance Yard (DWR-SMY)
Karen Hull, DWR - DFM, Sutter Maintenance Yard
Art Winslow, DWR - Executive Office
Curtis Anderson, DWR - Northern District (DWR-ND)
Kevin Dossey, DWR - Northern District
Bill McLaughlin, DWR - Northern District

Summary

- DWR-ND gave an overview of the proposed work plan, and the need for making improvements for fish passage at the Weir No. 2 structure.
- DWR-DFM stated the current structure is antiquated and not safe to operate. They would like DWR-ND to check if DWR is legally obligated to meet OSHA standards if the existing structure is upgraded. DWR-DFM has plans to replace the existing catwalk.
- DWR-DFM said automation would be preferred in a new structure to improve operation and maintenance rather than manually adjusting flashboards.
- USFWS has plans to improve the existing channels in the Sutter National Wildlife Refuge (SNWR) to improve refuge operations. USFWS feels that a screen would be required for their pump and not the entire diversion. Howard Brown from NMFS had been consulted on this matter and did concur.
- CDFG has concerns that fish could be stranded in the refuge if true flow through conditions did not exist, or in areas of ponded water. CDFG would prefer to screen the entrance of the diversion to the SNWR. USFWS and CDFG will need to work through this issue to decide if an alternative to tie a new SNWR fish screen to a new DWR fish ladder on the right bank of the East Borrow Canal is a viable alternative.
- USFWS stated that USBR is responsible for providing up to 65 cfs of “fish friendly” water (Level IV water) to the SNWR at the point of delivery.
- USFWS will contact USBR about the possibility of funding the rebuilding of Weir No. 2 since their diversion is dependent on the structure. DWR-DFM stated that

DWR does not have funding to rebuild the structure. CALFED may not be willing to fund that portion of the project if it is decided to rebuild Weir No. 2. CDFG would be opposed to spending any fish restoration money on improvements to a structure that wouldn't enhance fish passage. There are concerns about constructing a new fish ladder and tying it into an old, possibly unstable structure. Rebuilding Weir No. 2 will need to be justified. An inspection by a Structural Engineer should be made during a time of dewatering to determine the integrity of the existing structure. August or September would be the best time for dewatering.

- DWR-ND noted that during the site survey last summer, a large hole approximately 5 feet deep was discovered at the toe of the structure in the third bay from the right bank fish ladder.
- DWR-SMY performed a stream flow measurement downstream of Weir No. 2 on July 10, 2001. The measured flow was compared with an estimated weir flow calculation by DWR-ND at the structure and fish ladder that resulted in a discrepancy of approximately 40% less water (125 cfs - current meter measurement vs. 76 cfs - weir flow calculation). This very well could be an indication that the existing structure is leaking through/under the existing dam.
- CDFG stated they had recently purchased a 40 cfs instream flow for fish from October to June. This flow could be split between the West and East Borrow Canals.
- DWR-ND stated the current funding for the preliminary investigation runs out at the end of June. It is unknown at this time how much funding will be available after July 1.
- DWR-ND discussed the following initial alternatives:
    - <u>Alternative 1 – No Action.</u> The group decided this alternative was not a valid alternative.
    - <u>Alternative 2 – Remove Weir No. 2.</u> The group decided this is not a likely alternative since no alternative water supplies are available for upstream diverters at this time.
    - <u>Alternative 3 – Replace Weir No. 2 with a new weir and fish passage structure at the existing location (right bank or left bank fishway, or both banks).</u> This is a valid alternative at this time. DWR-DFM/SMY would prefer a left bank fish ladder for ease of operation and maintenance. Automation of the operations at a new weir structure would be preferred.
    - <u>Alternative 4 – Replace Weir No. 2 with a new weir and fish passage structure at the existing location (right bank fishway), and tie the fish ladder into the SNWR fish screen facilities and diversion canal entrance if the SNWR diversion point and proposed fish screen are moved down to Weir No. 2 to improve sweeping velocities past the screen.</u> A new SNWR fish screen tied to a new DWR fish ladder would provide improved hydraulics for the fish screen. This alternative is only valid if it is decided that the SNWR diversion needs to be fully screened.
    - <u>Alternative 5 – Replace Weir No. 2 with a new weir and right bank fish passage structure at the SNWR diversion site about 800 feet upstream. Tie fish ladder into the proposed SNWR fish screen facilities to improve</u>

sweeping velocities past the screen. A new SNWR fish screen tied to the new DWR fish ladder would provide improved hydraulics for the fish screen. This alternative is only valid if it is decided that the SNWR diversion needs to be fully screened. DWR would not be opposed to moving the new weir structure and new fish ladder upstream.

  - Alternative 6 – Remove the existing fish ladder and replace it (in the existing right bank location) with a state-of-the-art fish ladder, possibly including an auxiliary water system. This is a valid alternative at this time. Discussions leaned toward not including an auxiliary water system if a higher volume fish ladder with good entrance conditions is designed. Weir No. 2 would not be rebuilt, but could be upgraded.
  - Alternative 7 – Remove the existing fish ladder and replace it (in the existing right bank location) with a state-of-the-art fish ladder, possibly including an auxiliary water system. Plus, tie into SNWR diversion as described above. This alternative is only valid if it is decided that the SNWR diversion needs to be fully screened. An auxiliary water system is not preferable if a higher volume fish ladder and good entrance conditions is designed. Weir No. 2 would not be rebuilt but could be upgraded.
  - Alternative 8 – Remove the existing fish ladder and replace it (at the left bank to improve access) with a state-of-the-art fish ladder, possibly including an auxiliary water system. This is a valid alternative at this time. Weir No. 2 would not be rebuilt but could be upgraded. An auxiliary water system is not preferable if a higher volume fish ladder and good entrance conditions are designed. DWR-SMY/FM would prefer a left bank fish ladder for ease of maintenance.
- DWR-ND is analyzing the limited flow and stage data that exists for this area. Information being looked at is the Butte Slough near Meridian gage, Wadsworth Canal gage (decommissioned), Weir No. 2 headwater stage records, Weir No. 2 tailwater stage records (installed 7/01), and the Pumping Plant 2 staff gage. A typical 3-day delay design flow analysis is not feasible for this location due to the location of the Butte Slough near Meridian gaging station above the East/West Borrow Canal split and the seasonal flooding of the Sutter Bypass. A swim through condition will be estimated from this data.
- DWR-ND mentioned the new fish ladder would need to operate at a flow as low as 5 cfs, per CDFG. The upper flow range for a new fish ladder (without auxiliary flow) could be in the range of 50-65 cfs. The current pool and weir fish ladder has a flow capacity of 13 cfs (1-foot water depth) with a 2 to 2 ½ foot head differential. Potential new fish ladder options include, but are not limited to an Ice Harbor, Half Ice Harbor, and Vertical Slot types.
- DWR-ND mentioned that an effort would be made to incorporate the ability to dewater the new fish ladder for maintenance purposes. Bulkheads at the entrance and exit that are reachable by a boom truck or crane is a possibility. The use of gates or flashboards would be other options. DWR-SMY currently has a boom truck capable of lifting 800 pounds at a 35-foot reach and 13,000 pounds at a 7-foot reach.

- DWR-SMY/DFM would like to see the new fish ladder completely covered with grating. The grating panels should be large enough so that people can't remove the gratings by hand, but would be removable with a boom truck for maintenance purposes.
- DWR-ND mentioned that the May 1976 Sutter Bypass Study proposed rebuilding Weir No. 2 downstream of the existing location, keeping the existing structure, and modifying it to protect the new weir from large floating debris.
- The use of Obermeyer spillway gates, Amil automatic gates, or other types of control gates incorporated into a new Weir No. 2 structure was discussed. DWR-DFM does not want to see radial gates used. They would want any gate used to be of high quality to withstand submergence and debris flow conditions.
- Since the screening of the SNWR diversion is up in the air, the focus of the investigation at this time will be a left bank fish ladder. If a new SNWR fish screen is decided upon, the new fish ladder can be mirrored to the right bank. Upgrading vs. rebuilding Weir No. 2 will be looked at also.
- The next meeting was not scheduled, but will likely take place before the end of the month.

Lower Butte Creek - Sutter Bypass, Weir No. 2 Fish Passage Project
October 28, 2002 Meeting at Sutter Maintenance Yard
Meeting Summary

Attendees:

Olen Zirkle, Ducks Unlimited
Kevin Foerster, USFWS - Sacramento NWRC
Mike Peters, USFWS - Sacramento NWRC
Paul Ward, CDFG
Keith Swanson, DWR - Division of Flood Management (DFM)
Karen Hull, DWR - DFM, Sutter Maintenance Yard
Joel Farias, DWR - DFM, Sutter Maintenance Yard
Art Winslow, DWR - Executive Office
Mike Tucker – NMFS
Michael Lee, USBR
Mike Heaton, USBR
Curtis Anderson, DWR - Northern District
Bill McLaughlin, DWR - Northern District

Summary

- A brief review of the 5/30/02 meeting summary was discussed along with a summary of the initial alternatives for the project. No corrections or additions were suggested.
- A hydrologic summary was given for Weir No. 2. Due to the lack of gaging stations on the East Borrow Canal, only estimates of typical average daily flows could be calculated. Discharge information for the Butte Slough near Meridian gage from water years 1967 to 1998 and for the Wadsworth Canal near Sutter gage from water years 1976 to 1996 was used. In addition, a 50-50 and 60-40 flow split was used for the Butte Slough near Meridian gage and the entire Wadsworth Canal near Sutter flow to estimate flows in the East Borrow Canal.
- Since a typical 3-day delay design flow analysis for a new fish ladder is not possible due to the lack of hydrologic data at Weir No. 2 and the seasonal flooding that occurs in the Sutter Bypass, an estimate was made to determine when a swim through condition could possibly exist over the structure. For the estimate, a constant stage of 38.0' (USED) was used upstream of Weir No. 2 and flashboards removed for increased flows. The downstream water surface was estimated by Mannings equation and a HEC-RAS analysis for various flows. It appears that a swim through condition is not likely to occur past the structure during the diversion season. A swim through condition would only exist when all the flashboards in Weir No. 2 are removed to allow flood flows to pass.
- A summary of the 9/12/2002 Weir No. 2 structural inspection was given. It appears that the foundation is similar to the plans found for the initial 1925 structure. The plans show a 4" thick concrete foundation with sheet piling at the upstream and downstream ends. The inspection revealed the following:

- Concrete apron is heavily worn and aggregate is exposed.
- Three holes were found in the concrete apron:
  - The first hole, approximately 2 feet in diameter, is located in the third bay from the west bank of the structure. The concrete edges around the opening were rounded and the reinforcing steel was mostly intact. There is a large void beneath the apron at this location. The void measured 7 to 9 feet deep by 13 to 16 feet in diameter.
  - The second hole is also located in the third bay from the west bank of the structure. This hole is 1½ to 2 feet in diameter with a 1-foot deep void beneath the apron. This hole is near the downstream edge of the apron.
  - The third hole is located in the first bay from the west bank of the structure. This hole is 1½ to 2 feet in diameter with a 1 to 2-foot deep void beneath the apron.
- At the downstream edge of the apron, the depth to soil from top of concrete varies from 1½ feet on the east side to 3 feet on the west side.
- At the downstream edge of the apron, approximately 20 feet from the west abutment, a hole in the cutoff wall and an adjoining void were located beneath the apron. The void measured approximately 7 feet long in the direction of flow, and 1 to 2 feet wide.
- On top of the apron, near the fourth bay from the west side, there is a 3 to 4-foot diameter by 6 to 10-inch high mound of concrete or possibly asphalt.
- Rocks up to 9 inches in diameter were found on the apron floor within several bays.

* A copy of the complete structural evaluation memo will be sent out to the group.
* It is likely that rebuilding Weir No. 2 would be more cost effective rather than trying to make repairs to the existing structure to make it a reliable, watertight structure. If the structure is rebuilt, there may be permitting advantages to rebuilding at the same location. DWR-ND will look into that issue.
* Left bank fish ladder options were discussed with the group. The ladder types discussed were a full ice harbor, half ice harbor, and vertical slot. The full ice harbor fish ladder would have a capacity of 50 to 60 cfs with a pair of 4-foot wide weirs and 2-18” or 20” orifices. The half ice harbor fish ladder would have a capacity of 25 to 30 cfs with a single 4-foot wide weir and 1-18” or 20” orifice. The vertical slot fish ladder would have a capacity of 30 to 50 cfs with 12” or 15” slots. **The half ice harbor fish ladder was discarded due to the higher flow capacity of the full ice harbor and vertical slot fish ladders.** The June 30, 1998 Lower Butte Creek Project, Final Project Report recommends a new fish ladder having a capacity of at least 40 cfs.
* Two layout options were shown for the ladder types. A straight layout and a wrap around layout along the left bank were discussed. **The wrap around layout was preferred by the group because of the smaller footprint and accessibility for maintenance.**

- DFG and NMFS engineers not present at the meeting will be consulted to determine whether a full ice harbor or vertical slot fish ladder will be preferred for Weir No. 2.
- Modifications to Weir No. 2 were discussed. An early 1980's draft plan by DWR to replace Weir No. 2 with a constant upstream level gate and 7 bulkheads along with a new fish ladder was shared with the group.
- Information for a constant upstream level gate was presented to the group. The benefit of this type of gate incorporated into Weir No. 2 is that it operates automatically without outside power or a motor to maintain a constant upstream elevation. The drawback is that the flooding that occurs on-site almost annually would require a need to protect the gate from debris and require annual maintenance due to submergence. Removing the gate annually may not be feasible due to the 10-ton plus weight of the gate.
- Another option to incorporate into Weir No. 2 would be an Obermeyer spillway gate(s). This gate utilizes a large air bladder that raises and lowers a steel gate panel. Nice features of this type of gate is that it can be programmed to maintain a constant upstream elevation and can lay flat during the flood season without being removed. A drawback could be how reliable and durable the air bladder is. An instantaneous failure of the bladder/gate could cause a wall of water to be released past the structure. **If an Obermeyer gate is used, piers should be incorporated so that the gate can be isolated with bulkheads and repaired without a major dewatering effort.** A single Obermeyer gate can be incorporated along with bulkheads or multiple Obermeyer gates to make up the entire structure.
- **A new, wider platform will be incorporated across the piers of the Weir No. 2 structure. The new platform could be wide enough to accommodate a boom truck to install and remove bulkheads.**
- **A cost estimate(s) for a new Weir No. 2 structure with fish ladder will be prepared for the next meeting.**
- Concerns about fisheries dollars funding the construction of a new weir still exist. Even so, CalFed funding may not be available for a while.
- There was discussion about a previous plan to bring Feather River water from Sutter Extension Water District that would flow through Wadsworth Canal and then be siphoned under the East Borrow Canal to supply the refuge with water. There appears to be concerns about running the water through Wadsworth Canal including seepage onto adjacent farmlands. USBR will be meeting in the next few weeks to discuss this plan. USFWS is not in favor of this plan. Even if this plan is incorporated, removing Weir No. 2 does not seem to be an option since other private diverters and DWR's Pumping Plant No. 3 rely on the stage maintained by the existing structure.
- The next meeting was scheduled for December 19, 2002 at the Sutter Maintenance Yard.

Lower Butte Creek - Sutter Bypass, Weir No. 2 Fish Passage Project
December 19, 2002 Meeting at Sutter Maintenance Yard
Meeting Summary

Attendees:

Paul Ward, CDFG
Olen Zirkle, Ducks Unlimited
Keith Swanson, DWR - Division of Flood Management
Ken Dickerson, DWR, Sutter Maintenance Yard
Karen Hull, DWR - DFM, Sutter Maintenance Yard
Bryan Reniff, DWR - DFM, Sutter Maintenance Yard
Art Winslow, DWR - Executive Office
Debbie Carlisle, DWR - DPLA
Bill Peach, DWR - DPLA
Curtis Anderson, DWR - Northern District
Nancy Snodgrass, DWR - Northern District
Kevin Dossey, DWR - Northern District
Bill McLaughlin, DWR - Northern District
Mike Tucker, NMFS
Steve Thomas, NMFS
Paul Russell, Sutter Extension Water District
Dale Garrison, USFWS - Sacramento NWRC
Mike Peters, USFWS - Sacramento NWRC
Michael Lee, USBR
Buford Holt, USBR
Tim Rust, USBR

Summary

- The October 28, 2002 meeting was briefly discussed along with a review of the initial alternatives for the project. No corrections or additions were suggested.
- An overview of the meeting between USFWS and USBR regarding long-term water conveyance facilities to the Sutter National Wildlife Refuge was given. USFWS has asked USBR to re-investigate the option of moving Refuge water through Western Canal to Butte Creek to the Sutter Bypass to the Refuge. In addition, USFWS requested USBR to work with DWR on the Weir No. 2 issue, but funding will not likely be available for awhile. DWR will complete the final preliminary engineering report this summer and look at funding opportunities at that time.
- A short video on Obermeyer gates was shown that demonstrated their use in different applications.
- Draft layouts of a vertical slot and full ice harbor fish ladder were discussed.
- The entrance and exit for both fish ladders are identical except for their widths. The exit is oriented perpendicular to the flow to prevent over-excavation of the left bank of the East Borrow Canal levee and minimize debris problems.

Velocities are low in the East Borrow Canal, so adverse hydraulic conditions should not be introduced. This orientation should decrease debris in the fish ladder. A coarse trash rack will be included at the exit. The entrance pool includes three 2-foot wide entrance slots that will be controlled by flashboards. The entrances can direct attraction flows either upstream, perpendicular to flow, or downstream at an angle. There was a concern during the meeting that the slots may need to be widened to prevent difficult hydraulic conditions for fish entering the fish ladder. This concern will be looked into. It was noted during the meeting that the new East-West Diversion, Weir No. 3, and Weir No. 5 structures all utilize two-foot wide slots at their respective entrances. Plans for the projects show two 1-foot wide slots were designed for those projects. Recent flooding of the Sutter Bypass has submerged the structures, preventing observance of how the new entrances perform at this time.

- There was a concern that the area immediately upstream of the fish ladder entrances could accumulate sediment and harbor predator fish. Addition of concrete at a 45 degree angle to the walls to eliminate this dead area should alleviate these potential problems.
- Most stakeholders seemed to prefer the full ice harbor fish ladder over the vertical slot fish ladder. It was suggested that DWR meet with George Heise from DFG to get input for determining a preferable fish ladder.
    - DWR met with George Heise on January 10, 2003 after information on the project was e-mailed to him. George felt that either fish ladder would function fine at Weir No. 2 and did not have a strong preference between them. George will be added to the stakeholder list for future meetings.
- Obermeyer type gates are preferred by the group over constant-upstream-head gates for incorporation into a new weir design to provide automated control of stage upstream of Weir No. 2.
- It was suggested that DWR give a short presentation to the Anadromous Fish Screening Program (AFSP) group to get their input on the project. The next AFSP meeting is scheduled for January 9, 2003 at the USBR office in Sacramento.
    - A short presentation was given to the AFSP group on January 9, 2003. Comments by the group were limited.
- Some cost estimates were not yet received by manufacturers. Thus, draft project cost estimates were not prepared for the meeting. DWR will e-mail draft cost estimates to the group in the latter part of January.
- The next meeting was scheduled for February 20, 2003 from 9:00 am to 1:00 pm at the Sutter Maintenance Yard.
- An initial Willow Slough Weir Fish Passage Project stakeholder meeting will immediately follow. That meeting should last about 1 hour.

Lower Butte Creek - Sutter Bypass, Weir No. 2 Fish Passage Project
February 27, 2003 Meeting at Sutter Maintenance Yard
Meeting Summary

Attendees:

Paul Ward, CDFG
Olen Zirkle, Ducks Unlimited
Keith Swanson, DWR - Division of Flood Management
Ken Dickerson, DWR, Sutter Maintenance Yard
Art Winslow, DWR - Executive Office
Varda Disho, DWR - DPLA
Curtis Anderson, DWR - Northern District
Nancy Snodgrass, DWR - Northern District
Bill McLaughlin, DWR - Northern District
Steve Thomas, NMFS
Paul Russell, Sutter Extension Water District
Dale Garrison, USFWS - Sacramento NWRC
Mike Peters, USFWS - Sacramento NWRC
Steve Kasik, USFWS - Sacramento NWRC
Cesar Blanco, USFWS - AFRP
Michael Lee, USBR

Summary

- No corrections or additions were suggested for the 12/19/2002 meeting summary.
- Selection of the Full Ice Harbor or Vertical Slot fish ladder was discussed. The operation of the entrance and exits of the two ladders are the same since the entrances and exits are identical. The only difference would be the adjustments of a few weir boards in the upper 2 or 3 baffles and installing/removing stop gates on the orifices of the Full Ice Harbor at flows of less than 60 cfs. The consensus was that the multiple passage routes (2 weirs/2 orifices) of the Full Ice Harbor fish ladder was preferred over the single slots of the Vertical Slot fish ladder. A concern over the ability of the vertical slot to function at low flows was also a factor. (DWR is being asked to design for a minimum flow of 5 cfs).
- One set of weirs of the 2 or 3 upper baffles will be designed to be adjustable to provide flexibility if the upstream stage should drop below the typical water surface elevation of 38.5' (USED). The rest of the weirs will be fixed concrete.
- DWR proposed a change to the fish ladder entrance. Rather than extending the entrance into the channel to accommodate a downstream entrance, the entrance wall is now flush with the rest of the fish ladder. The entrances are now perpendicular to the flow in the East Borrow Canal. This change eliminates the dead area that was discussed during the previous meeting. The dead area between the fish ladder and weir structure would be prone to sediment accumulation and harboring predatory fish. One of the 3 entrances will be

eliminated since it was located too close to the last baffle and would create hydraulic problems. It was suggested that wing walls could be added to one of the entrances to provide a downstream directed entrance.

- Head differences will be controlled by a pair of entrance slots (currently 2' wide) that can be used independently or together. The fish ladder will operate with 60 cfs of flow most of the time. The exception would be during low flow periods in the East Borrow Canal of less than 60 cfs.
- Typical entrance conditions for the new fish ladder were discussed. The new fish ladder is being designed to accommodate the lowest downstream elevation of 24.52' USED recorded on April 17, 1991. Sutter Maintenance Yard staff was asked to monitor a downstream staff gage at Weir No. 2 for two years (2001-2002). The average stage during this period for the irrigation season was 29.81' USED. The first few baffles will likely be inundated a majority of the time.
- The layout of a new weir structure was discussed. The plan is to replace the structure at the same location since keeping the existing structure in place to act as a trash rack would add to maintenance duties. Previous discussions considered rebuilding the new structure downstream of the existing one.
- A new weir layout was presented and discussed. A Full Ice Harbor fish ladder with the updated entrance was included. The new layout also included two spillway gates located in the center bays of the new structure. The proposed new structure consisted of 6 - 12' wide bays for a total flow width of 77' including piers. This is a slight reduction from the existing structure that has a total flow width of approximately 80'. Flood Management staff said the 12' wide bays for bulkhead and stop logs in the manually operated bays are too wide for maintenance, and should be reduced to 6'. DWR was asked to look into the addition of a 3rd or 4th spillway gate that would reduce and minimize the need to operate the manual bays. This will be looked into and presented at or prior to the next meeting.
- A working platform versus a drivable deck across the new structure was discussed. It was suggested that costs could be saved by incorporating a working platform that would be wider than the existing platform. A mobile crane or gantry system would need to be used to remove/place bulkheads within the structure. The other option would be to design a drivable deck that would support a boom truck to maintain the bulkheads. Flood Management prefers the drivable deck for easier maintenance of the structure. Sutter Yard would like the deck to be removable during winter time flows. The Sutter National Wildlife Refuge would like to see an open span within the structure so people can't access the refuge. Some sort of drivable or partially drivable deck appears to be the preferred option at this time. Introducing a 3rd or 4th spillway gate could factor into what type of access would be needed for the structure. If winter flows could be handled with 3 or 4 spillway gates (at a cost agreeable to the group), occasional bulkhead removals/placements may be cost effective by utilizing a crane instead of a drivable deck.
- It is anticipated at this time that a new fish ladder and new weir structure with 2 spillway gates would be in the low $3,000,000 range. The same structures

incorporating 6 spillway gates would likely be in the $4,500,000 range. Costs are continually be updated as the details of the project are worked out.

- DWR provided a short presentation on the upcoming Willow Slough Fish Passage Project.
- The next meeting was scheduled for April 23, 2003 at 10:00 am, at the Sutter Maintenance Yard.

Lower Butte Creek - Sutter Bypass, Weir No. 2 Fish Passage Project
April 23, 2003 Meeting at Sutter Maintenance Yard
Meeting Summary

Attendees:

Paul Ward, CDFG
Tracy McReynolds, CDFG
Michele Ng, DWR - Division of Flood Management
Ken Dickerson, DWR, Sutter Maintenance Yard
Art Winslow, DWR - Executive Office
Nancy Snodgrass, DWR - Northern District
Bill McLaughlin, DWR - Northern District
Steve Thomas, NMFS
Mike Peters, USFWS - Sacramento NWRC
David Hu, USFWS - AFRP
Michael Lee, USBR

Summary

- A short summary of the 02/27/03 meeting was given. No changes were suggested for the summary.
- The entrance slots for the full ice harbor fish ladder were discussed. A third entrance slot was proposed in the chamfered turning pool wall directing flow downstream at a 45° angle. Since the bottom portion of the fish ladder will be submerged during typical tailwater stages in the East Borrow Canal (EBC), this entrance would provide a shorter passage route for fish that enter at this location.
- Water column depths of flow out of the entrance slots were discussed. For a 1' wide slot, a single column depth of about 12' or two columns depths of about 6' would be needed to pass the design flow of 58 cfs. Lower than average tailwater surfaces could cause backwater effects when sufficient water column depths are not present at the entrance which would create an unfavorable fish passage condition. For 2' wide slots, a single column depth of about 6.5' or two columns depths of about 3.5' would be needed to pass the design flow of 58 cfs. It was decided that the upstream most entrance (closest to the weir) would be a 1.5' wide entrance slot and the other two (main and turning pool entrances) would be 2' wide entrances.
- The hydraulic effect of having 2, 3, or 4 spillway gates incorporated into the new weir structure was discussed. For a new structure with 2 spillway gates, velocities of approximately 9 - 10 fps would likely exist for passage past the gates and some adjustments to manual stoplogs/bulkheads may be required to prevent any backwater effects. A structure with 3 spillway gates would have velocities of approximately 5 - 6 fps for passage past the gates. Adjustments to manual stoplogs/bulkheads are not likely required to pass flood flows. A new structure with 4 spillway gates would have velocities of about 4 - 5 fps. No adjustments of manual stoplogs/bulkheads would be needed for flood flows.

- The group decided that the cost difference between 2 or 3 spillway gates should be provided to the group in order to determine a preferred alternative for a new weir structure.
    - An e-mail was sent to the group with cost information for the spillway gate options on 5/7/2003. The responses received all favored the 3 spillway gate as the preferred option.
- Limited access to the refuge was suggested by having removable working platforms. This can probably be accommodated by DWR Sutter Maintenance Yard staff as long as operations are not affected.
- The importance of maintaining a constant 38.5' (USED) elevation was emphasized due to recent work that is being done to upgrade the Sutter National Wildlife Refuge (SNWR) ditch system. A small drop in stage reduces the diversion amount into the SNWR's diversion ditch.
- It was suggested that a presentation be made to the Anadromous Fish Screening Program (AFSP) group when the draft report is complete.
- It was also suggested to keep the Reclamation Board aware of what is going on with the project. They will be contacted with regards to preliminary geology work and the project itself.
- A preliminary geologic and environmental inspection will be included in the appendix of the final report.
- Another meeting for the Weir No. 2 Fish Passage Project was not scheduled. The plan is to distribute drawings to the group for review at the end of May or early part of June. The preliminary engineering technical report will be written as the drawings are being reviewed.

Appendix B Table of Contents

Estimated Average East Borrow Canal Flows (Butte Slough near Meridian (WY's 1967 to 1998) and Wadsworth Canal near Sutter (WY's 1976 to 1996)

Estimate does not include diversions that exist within this reach. Diversions are ungaged.

East Borrow Canal near Weir 2 (Butte Slough Split and Wadsworth Canal)

50% Flow Split

	October	November	December	January	February	March	April	May	June	July	August	September
Avg.	173	477	1769	5525	5784	4122	1228	455	319	213	283	321
Max.	706	12758	53500	86540	78760	92650	50880	15302	14976	612	696	931
Min.	3	12	52	49	41	64	15	1	0	0	1	11

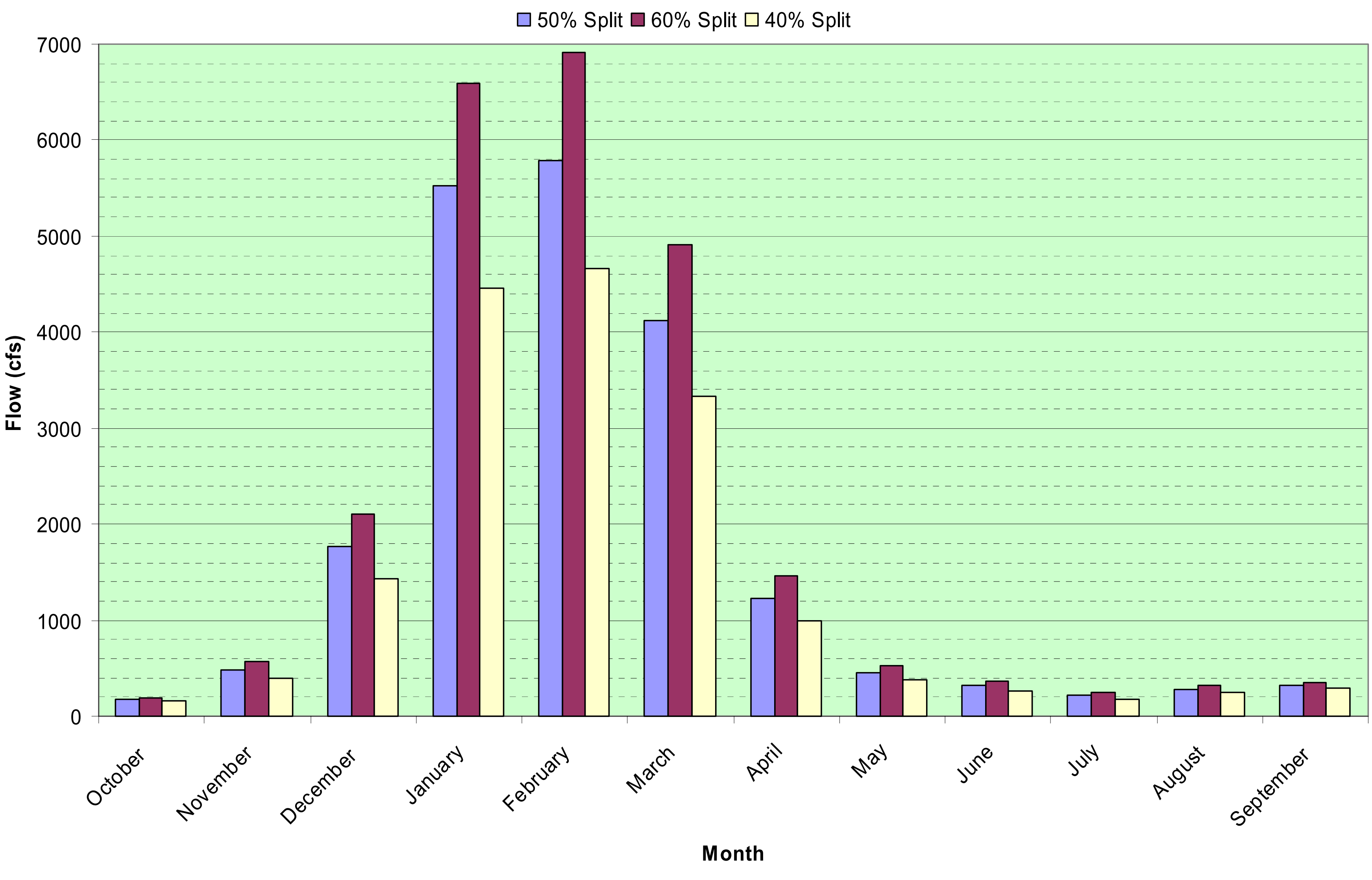
60 % Flow Split

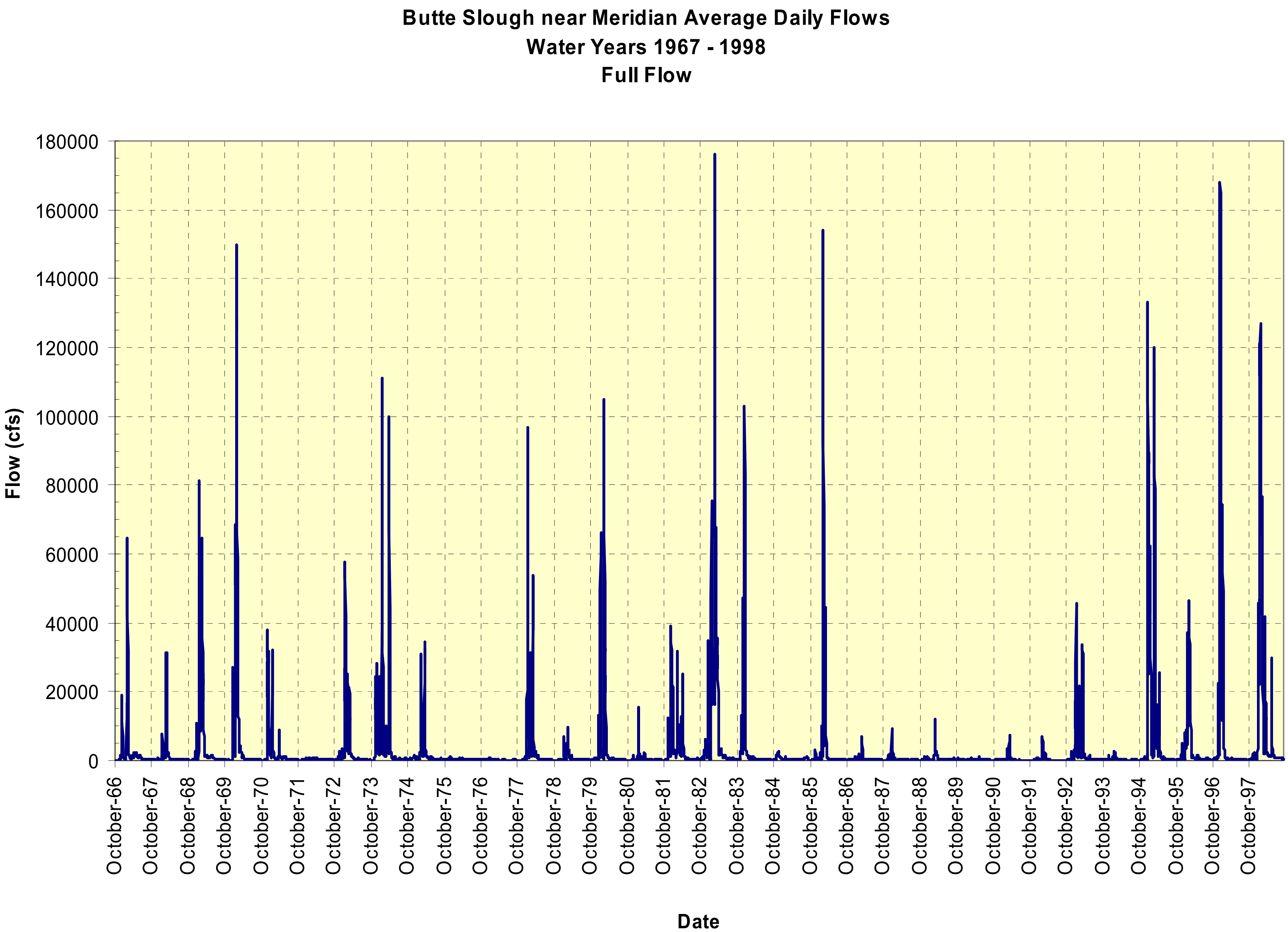
	October	November	December	January	February	March	April	May	June	July	August	September
Avg.	189	563	2106	6597	6909	4911	1456	530	370	245	319	352
Max.	802	15178	63800	103340	94160	110250	60880	18292	17916	710	782	1043
Min.	3	14	62	58	49	76	18	1	0	0	1	13

40% Flow Split

	October	November	December	January	February	March	April	May	June	July	August	September
Avg.	158	392	1432	4453	4659	3333	1000	380	268	180	248	290
Max.	609	10338	43200	69740	63360	75050	40880	12312	12036	513	609	819
Min.	2	9	42	40	32	51	12	1	0	0	1	8

Estimated Average East Borrow Canal Flows
Butte Slough near Meridian and Wadsworth Canal near Sutter
(Estimate does not include diversions)





Butte Slough near Meridian Average Daily Flows
Water Years 1967 - 1998
Full Flow
Flow (cfs)
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
October-66
October-67
October-68
October-69
October-70
October-71
October-72
October-73
October-74
October-75
October-76
October-77
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October-79
October-80
October-81
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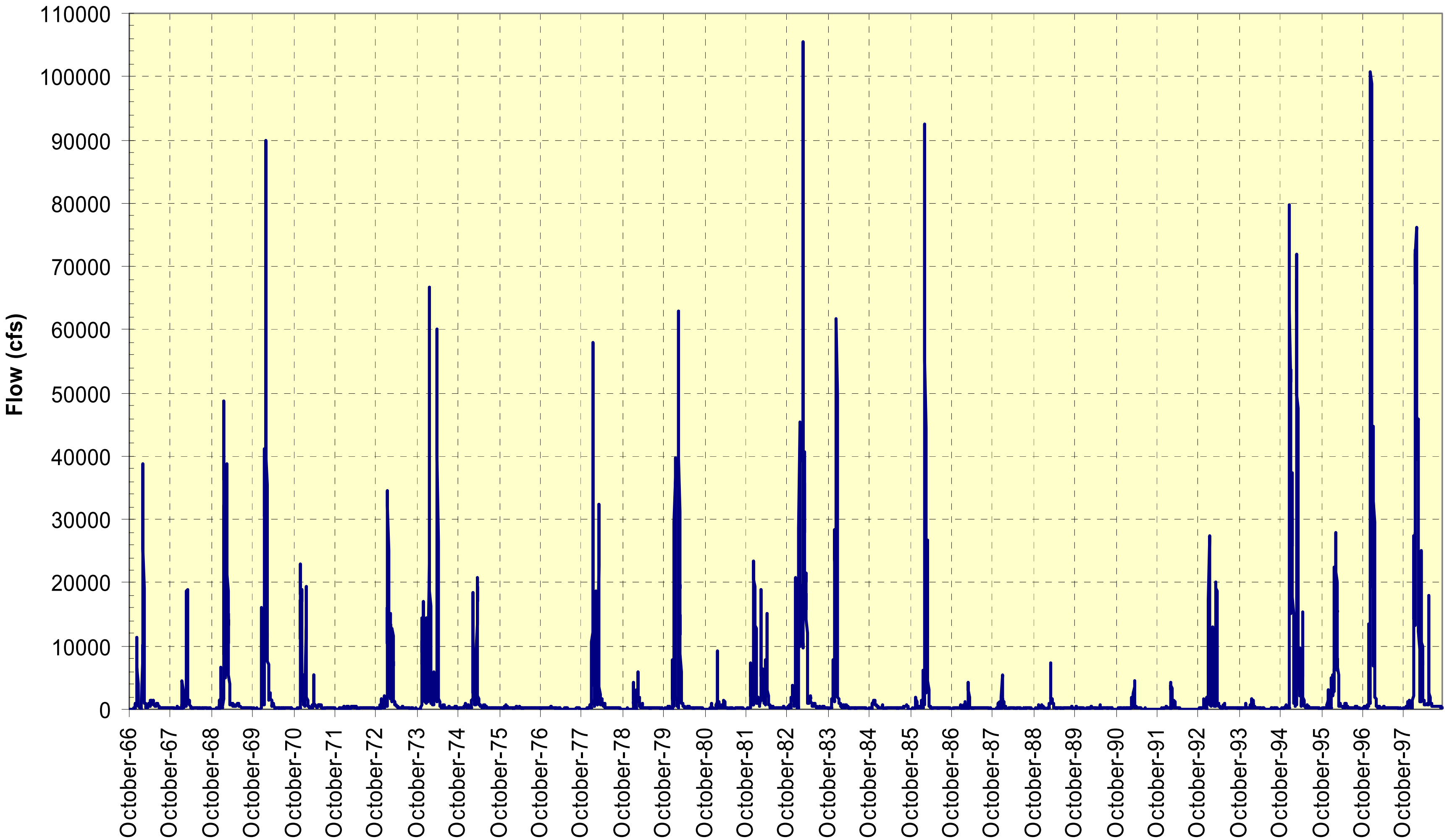
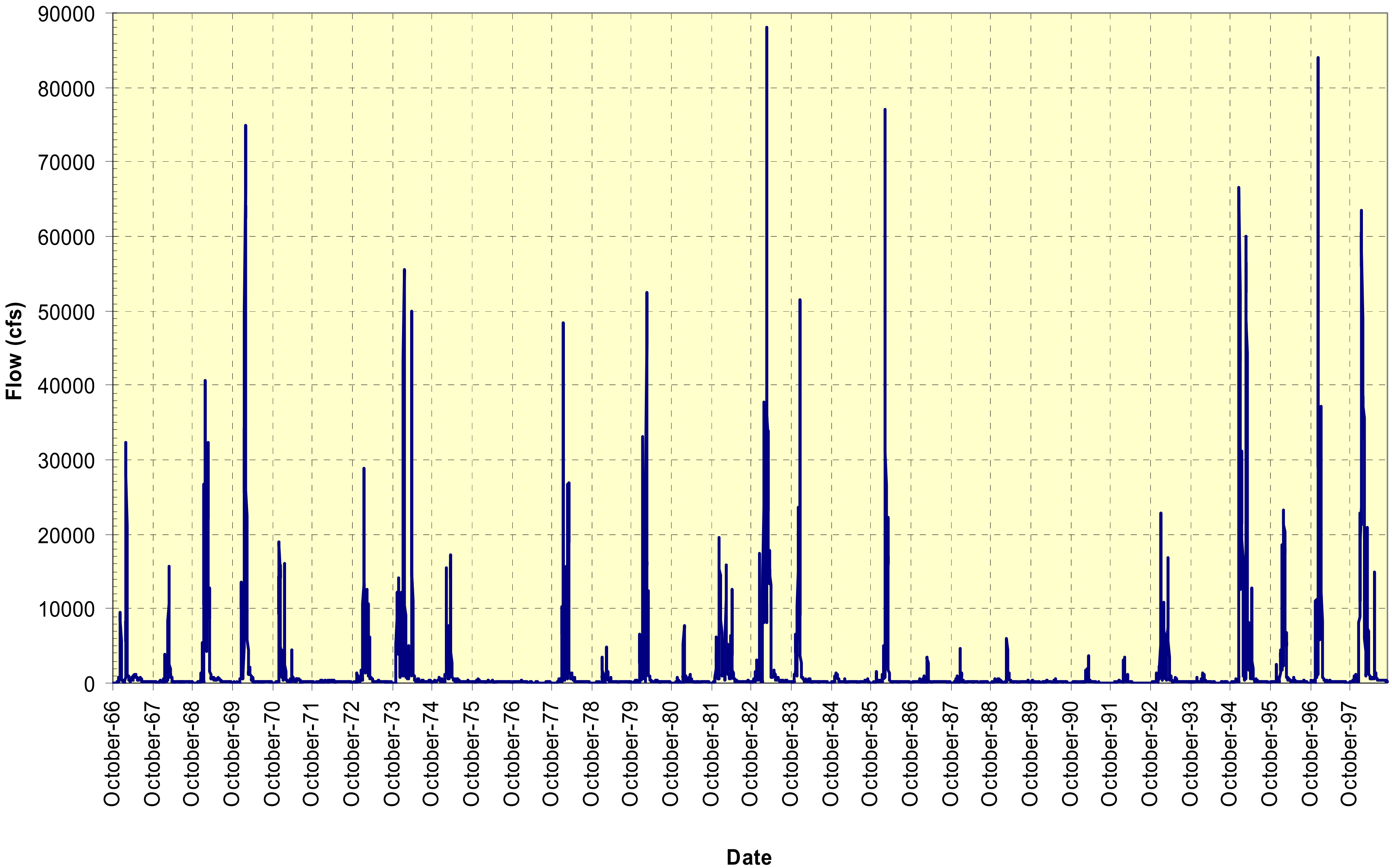
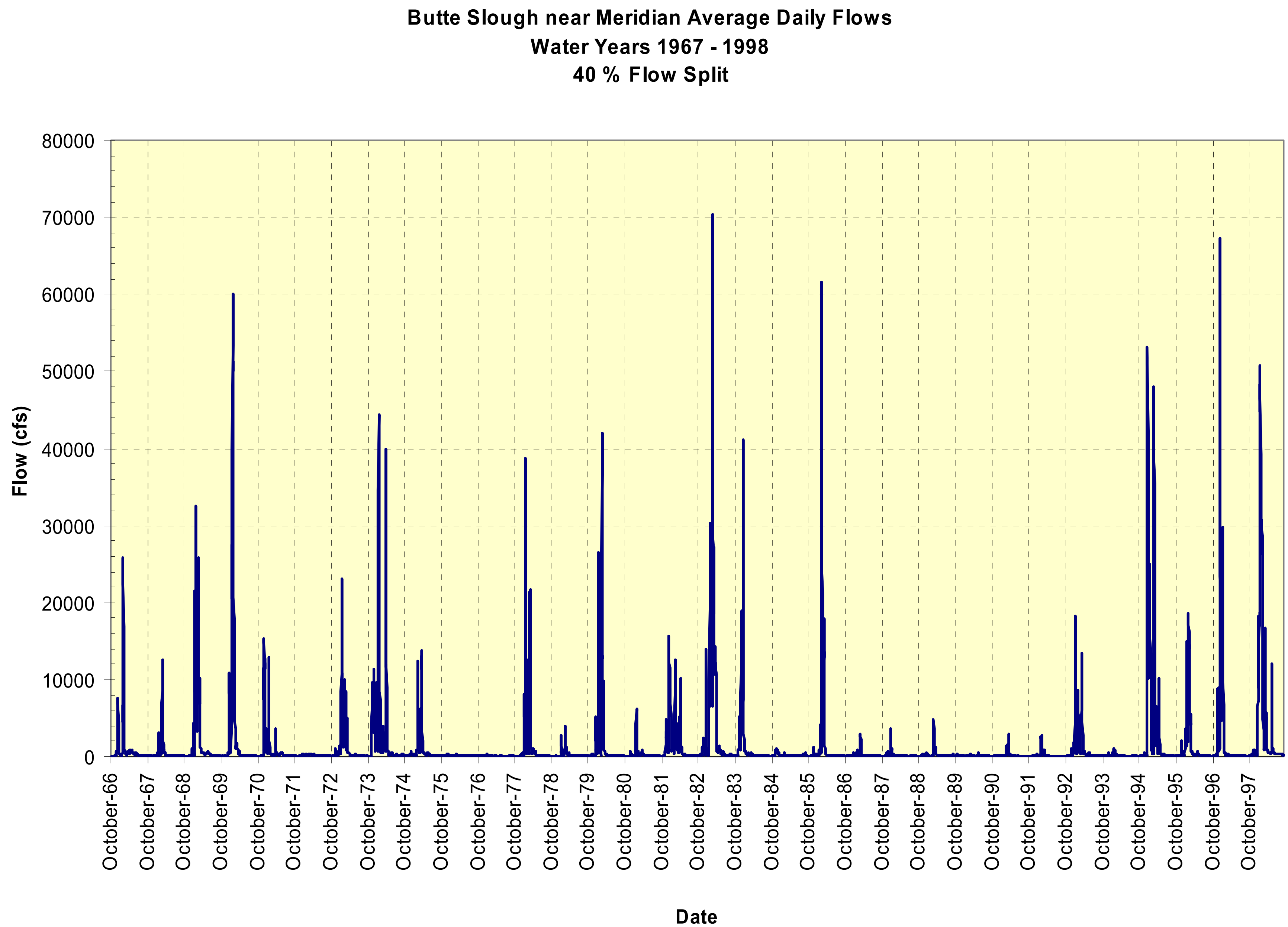
October-95
October-96
October-97
Date

Butte Slough near Meridian Average Daily Flows
Water Years 1967 - 1998
60 % Flow Split



Butte Slough near Meridian Average Daily Flows
Water Years 1967 - 1998
50 % Flow Split




Butte Slough near Meridian Average Daily Flows
Water Years 1967 - 1998
40 % Flow Split
Flow (cfs)
80000
70000
60000
50000
40000
30000
20000
10000
0
October-66
October-67
October-68
October-69
October-70
October-71
October-72
October-73
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October-79
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October-96
October-97
Date

Butte Slough near Meridian Average Daily Flow Monthly Exceedances (Water Years 1967 to 1998)

Full Flow

Exceedance	October	November	December	January	February	March	April	May	June	July	August	September
90%	48	116	195	222	226	276	228	204	104	95	206	122
75%	89	175	282	324	389	465	300	278	225	261	274	191
66.6%	104	208	355	416	703	688	335	310	258	284	301	230
50%	127	267	494	904	1380	1250	452	374	309	325	357	289
33.3%	170	373	1030	2800	4680	2400	978	482	375	360	402	350
25%	203	466	1470	7590	11700	4010	1290	691	452	388	432	387
10%	267	1430	10600	40400	36100	27100	2950	1240	961	482	527	514
5%	327	2950	20400	59400	62100	39100	11100	1560	1330	575	663	635

50% Flow

Exceedance	October	November	December	January	February	March	April	May	June	July	August	September
90%	24	58	98	111	113	138	114	102	52	48	103	61
75%	45	88	141	162	195	233	150	139	113	131	137	96
66.6%	52	104	178	208	352	344	168	155	129	142	151	115
50%	64	134	247	452	690	625	226	187	155	163	179	145
33.3%	85	187	515	1400	2340	1200	489	241	188	180	201	175
25%	102	233	735	3795	5850	2005	645	346	226	194	216	194
10%	134	715	5300	20200	18050	13550	1475	620	481	241	264	257
5%	164	1475	10200	29700	31050	19550	5550	780	665	288	332	318

60% Flow

Exceedance	October	November	December	January	February	March	April	May	June	July	August	September
90%	29	70	117	133	136	166	137	122	62	57	124	73
75%	53	105	169	194	233	279	180	167	135	157	164	115
66.6%	62	125	213	250	422	413	201	186	155	170	181	138
50%	76	160	296	542	828	750	271	224	185	195	214	173
33.3%	102	224	618	1680	2808	1440	587	289	225	216	241	210
25%	122	280	882	4554	7020	2406	774	415	271	233	259	232
10%	160	858	6360	24240	21660	16260	1770	744	577	289	316	308
5%	196	1770	12240	35640	37260	23460	6660	936	798	345	398	381

40% Flow

Exceedance	October	November	December	January	February	March	April	May	June	July	August	September
90%	19	46	78	89	90	110	91	82	42	38	82	49
75%	36	70	113	130	156	186	120	111	90	104	110	76
66.6%	42	83	142	166	281	275	134	124	103	114	120	92
50%	51	107	198	362	552	500	181	150	124	130	143	116
33.3%	68	149	412	1120	1872	960	391	193	150	144	161	140
25%	81	186	588	3036	4680	1604	516	276	181	155	173	155
10%	107	572	4240	16160	14440	10840	1180	496	384	193	211	206
5%	131	1180	8160	23760	24840	15640	4440	624	532	230	265	254

Appendix C Table of Contents

State of California

The Resources Agency

Memorandum

Date: OCT 25 2002

To: William McLaughlin, Associate Engineer
Northern District

Timothy Talbert, Sr. Structural Specialist
Division of Engineering

From: Department of Water Resources

Subject: Weir No. 2 Structural Evaluation

Introduction

On August 9, 2002, you requested that the Division of Engineering, Structures Section perform an evaluation of Weir No. 2, which is located in the East Borrow Canal of the Sutter Bypass. You indicated that a new fish ladder is being proposed to replace an existing, poorly functioning fish ladder at the weir structure and that there are general concerns regarding the integrity of the structure's foundation. You also indicated that past flow measurements at the weir and just downstream of the weir indicate that seepage under the foundation may be significant.

This memorandum transmits the results of the Structures Section's evaluation, which includes an assessment of the current condition of the weir structure, constructability of a new fish ladder, and recommendations for the current weir structure. The evaluation is based on a review of engineering drawings and two site inspections.

Weir Structure Description

The weir structure consists of a reinforced concrete apron, 11 reinforced concrete piers, and a concrete steppool fish ladder incorporated into the west abutment. The concrete apron, originally constructed in 1925, is 104 feet long, 35 feet wide and four inches thick. Sheet pile cutoff walls are integrated into the apron at its upstream and downstream edges. The apron and cutoff walls form the foundation for the weir structure. The concrete piers, approximately 12-1/2 feet tall, were constructed in 1946 to replace a timber flashboard-type dam built as part of the original structure. The piers provide support for removable timber flashboards. The flashboards are in place during the spring, summer and fall to increase water depth within the canal upstream of the weir structure, which is necessary for the Sutter National Wildlife Refuge and agricultural water diversions. The flashboards are removed in the winter to allow for passage of high canal flows.

SURNAME
DWR 155 (Rev 4/02) Talbert 10/25/02

Site Inspections

I inspected the site on August 15, 2002. On this day, the weir flashboards were in place and water was flowing over the top flashboard in each of the 12 bays. The water depths were approximately 10 feet on the upstream side of the flashboards and three feet on the downstream side. The weir structure visible (above water) appeared to be in good condition with no signs of deterioration. Since the condition of the submerged portion of the structure could not be adequately assessed, an underwater inspection of the structure was scheduled to investigate a known hole in the concrete floor (found previously by a Northern District survey crew).

On September 12, 2002, an underwater inspection of the weir was conducted. In order to perform this inspection, it was necessary to reduce the flow through the weir structure as much as possible. To accomplish this, Flood Management – Sutter Maintenance Yard staff removed all of the weir's flashboards the day before the inspection and then replaced them just prior to divers entering the water. This reduced the flow to the amount of leakage between the flashboards; there was no flow over the top of the flashboards. The inspection revealed the following:

- Concrete apron is heavily worn and aggregate is exposed.
- Three holes were found in the concrete apron:
    - The first hole, approximately 2 feet in diameter, is located in the third bay from the west bank of the structure. The concrete edges around the opening were rounded and the reinforcing steel was mostly intact. There is a large void beneath the apron at this location. The void measured 7 to 9 feet deep by 13 to 16 feet in diameter.
    - The second hole is also located in the third bay from the west bank of the structure. This hole is 1-1/2 to 2 feet in diameter with a 1-foot deep void beneath the apron. This hole is near the downstream edge of the apron.
    - The third hole is located in the first bay from the west bank of the structure. This hole is 1-1/2 to 2 feet in diameter with a 1 to 2-foot deep void beneath the apron.
- At the downstream edge of the apron, the depth to soil from top of concrete varies from 1-1/2 feet on the east side to 3 feet on the west side.

- At the downstream edge of the apron, approximately 20 feet from the west abutment, a hole in the cutoff wall and an adjoining void were located beneath the apron. The void measured approximately 7 feet long in the direction of flow, and 1 to 2 feet wide.

- On top of the apron, near the fourth bay from the west side, there is a 3 to 4-foot diameter by 6 to 10-inch high mound of concrete or possibly asphalt.

- Rocks up to 9 inches in diameter were found on the apron floor within several bays.

The attached drawing shows the findings of the underwater inspection.

Conclusions

The weir's foundation, which includes the concrete apron and cutoff walls, shows signs of significant deterioration, while the concrete piers and abutments appear to be in good condition. Without corrective actions, this deterioration will continue until foundation failure occurs, which would likely render the weir structure inoperable. The following are important areas of concern:

- Significant damage to concrete apron - The apron is extremely worn and in three locations the concrete has completely worn away, allowing the underlying soil to erode. In the worst location, the third bay from the west abutment, the erosion has lead to significant undermining of the apron and a concrete pier. Failure of the apron at this location could cause the supported pier to topple, rendering the weir structure inoperable.

- Seepage through cutoff wall - There is a hole in the downstream cutoff wall along with an adjoining void. This indicates that seepage does occur and that the seepage is sufficient to erode the underling soil. In addition, given the age of the cutoff wall, it is probable that other holes exist.

- Extent of undermining is unknown, but appears to be significant - Given the defects in the apron and cutoff wall and the likelihood of additional undetected defects, it is probable that the extent of undermining is much worse than the weir inspections reveal.

New Fish Ladder Constructability

Replacing the existing Weir No. 2 fish ladder with a new fish ladder is possible. Based on Northern District's preliminary concepts for a new fish ladder, the work would include the following:

- Dewater the work site - likely using earthen coffer dams located upstream and downstream of the weir structure.
- Demolish the existing fish ladder and two to three eastern weir bays.
- Excavate foundation.
- Replace the existing fish ladder with new weir bays.
- Replace the two to three weir bays near the east abutment with a new fish ladder.

An operational fish ladder at this location requires an operational weir. Constructing a new fish ladder designed to operate for 30 or more years requires that the weir be operational for the same period of time. The options to achieve this level of weir service are to improve the existing weir structure or replace it.

Significant cost savings could be achieved if weir improvements coincide with the replacement of the fish ladder: dewatering and mobilization costs would be avoided along with other economies of scale savings, including inspection and contract administration costs savings. Therefore, for the purpose of this evaluation, it is assumed that any weir improvement work would coincide with fish ladder replacement.

Minimum weir improvements necessary for an adequate service life include:

- Coring and grouting concrete apron to eliminate voids.
- Reconstructing upstream and downstream seepage cutoff walls.
- Covering the entire apron with a wear layer of high-strength concrete.
- Placing riprap to prevent erosion at downstream edge of apron.
- Replacing the access platform with a safe, all-weather access platform.

Replacing the weir with a structure meeting current design standards would guarantee a sound structure and allow for operational improvements. The current method for removing and installing flashboards are labor intensive. A new weir structure could include features to ease flashboard removal and installation. Construction of a replacement weir would include:

- Demolition of weir structure.

- Construction of upstream and downstream cutoff walls, concrete apron, and concrete piers. The east abutment appears sound and likely would remain in place.

- Construction of an access platform.

- Installation of flashboard/bulkhead lifting device or use of a boom truck or crane.

Assuming that funding is available for either option at the time the new fish ladder is constructed, I recommend that the weir structure be replaced. The amount of work required to replace the weir is not significantly more than that required to improve the existing weir and there are additional safety and operational benefits.

Recommendations for Current Weir Structure

The weir site inspections revealed signs of significant structural deterioration. In order to prevent further deterioration and possible structural failure, I recommend that the following actions be taken as soon as possible:

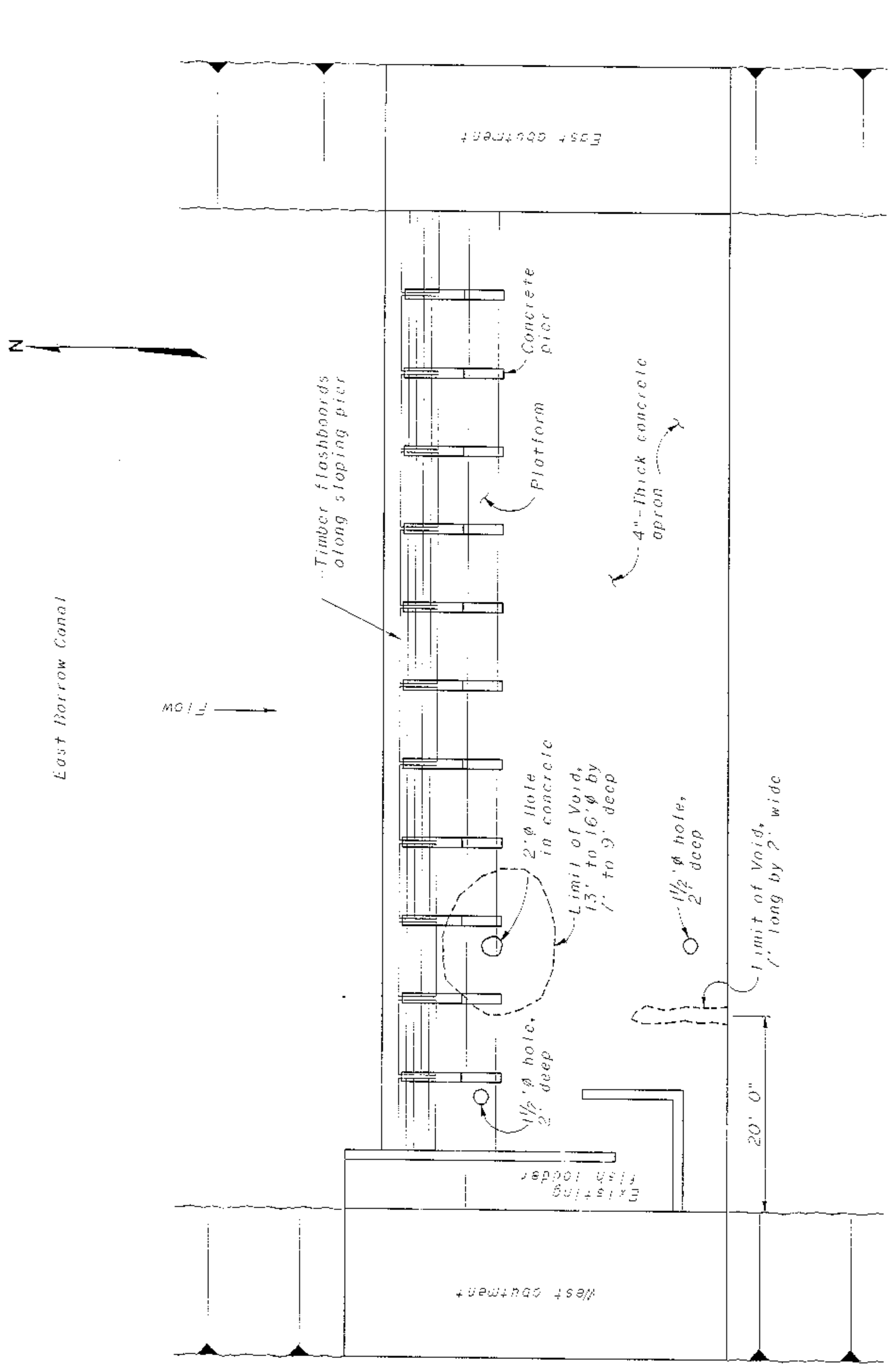
- Fill all known voids with concrete to prevent further soil erosion and apron undermining.

- Re-inspect weir apron by sealing flashboards with plastic so that seepage through the flashboards is minimized. This will allow a more complete investigation of the apron and possibly allow detection of seepage under the apron.

- Institute a weir inspection plan that includes thorough periodic inspections of the apron. The apron has worn completely away in three areas and will likely wear away in other areas. When new holes are found, they should be filled with concrete as soon as possible.

These actions should be considered an intermediate fix until the weir structure is either replaced or significantly improved. The weir foundation consists of a nearly 80-year-old concrete apron connected to steel sheet pile cutoff walls. This foundation is significantly deteriorated and will continue to deteriorate until more permanent improvements can be made.

cc: J. Schallberger, DOE, Rm. 313-B, Bonderson
C. Diaz, DOE, Rm. 313-A, Bonderson
K. Swanson, DOFM, Rm. 114
K. Dickerson, DOFM, Sutter Maintenance Yard



WEIR 2 PLAN

⅛" = 1'
10 0 10 20 30
SCALE OF FEET

Appendix D Table of Contents

State of California

The Resources Agency

Memorandum

Date: December 29, 2003

Project Geology
Report No. 94-00-22

To: Bill McLaughlin
Northern District, DPLA

From: Frank L. Glick, Chief
Project Geology Section
Department of Water Resources

Subject: Sutter Bypass Improvements, Weir No. 2; Results of Geologic Exploration Program

Introduction

Pursuant to your May 2003 request for a geologic foundation investigation of the Sutter Bypass Weir No. 2 structure, and subsequent communications with Brent Lamkin of my staff, we have prepared this report of geologic conditions. This report was prepared by Mr. Lamkin, with assistance from Al Laguardia and Shelly Asbury, of Project Geology. Geologic exploration for the site was conducted by Project Geology on June 23 and 24, 2003, pursuant to the exploration proposal transmitted from Brent Lamkin to you on June 9, 2003.

Our understanding is that the existing structure was constructed in 1925, modified in the 1940s, and is now deteriorating with the foundation being undercut by water flowing beneath the structure. A structural evaluation of the existing structure was conducted by Tim Talbert, of the Division of Engineering's Civil Engineering Branch, in August and September 2002 (Attachment 1). While Mr. Talbert's assessment found severe problems with the concrete slab footing and sheet-pile cut-off walls, no signs of settlement or other soil foundation problems were noted except for undercutting by erosion. The results of that evaluation precipitated the planning and design for replacement of the weir. Northern District is currently preparing a preliminary design for a replacement weir structure at the same location as the existing weir.

The Weir No. 2 structure is located in Sutter County, on the east side of the Sutter Bypass, approximately eight miles west-southwest of Yuba City (Plate 1). The weir controls water flow and stage in the East Borrow Canal, along the eastern edge of the Sutter Bypass. An existing fish ladder provides fish passage past the Weir Number 2 structure.

SURNAME
DWR 155 (Rev 4/02)

B. Lamkin 12/29/03	12/29/03	

Previous Geologic Investigation

Geologic exploration was conducted for, and a new weir structure was designed, to replace the existing structure in the mid-1980s. The new weir was to have been located approximately 100 feet south of the current structure, and was designed by staff of the Division of Design and Construction (now Division of Engineering). Project Geology drilled two exploration borings (SB-1 and SB-2) of 51.5 and 61.5 feet below ground surface on the abutments of the proposed weir (Plate 2). Those borings showed that site soils consisted mainly of lean clays, but also included clayey sands, silty sands, silt, and a poorly graded sand at the surface of the right (west) abutment. Uncorrected Standard Penetration Test (SPT) values ranged from N=2 (clayey sand at 9 feet bgs) to N=97 (clayey sand at 25 feet bgs); generally, the soils were very stiff or dense, and were deemed to be suitable for the proposed structure. The structure, however, was never built. A copy of the May 1986 Project Geology memorandum report of geologic exploration is included as Attachment 2.

2003 Geologic Exploration

On June 23 and 24, 2003, two exploration borings (SW2-1 and SW2-2) were drilled at the site to characterize foundation conditions for the replacement weir structure (Plate 2); SW2-1 was located about 25 feet east of the existing weir, while SW2-2 was drilled approximately 20 feet west of the weir's left abutment (Plate 2). Soils encountered in the borings were logged (Attachment 3) using the Unified Soil Classification System pursuant to ASTM Standard D 2488 by Tim Todd, Engineering Geologist (Range C), from the Project Geology Section. Mr. Todd also directed the drilling and sampling activities by the drilling Contractor. Both borings were drilled by Spectrum Exploration, of Stockton, California using a Central Mine Equipment Model 85 rubber-tired drill-rig. The borings were advanced to 60.0 feet below ground surface (bgs) using 8.25-inch O.D. hollow-stem augers. Auger cuttings were spread adjacent to each drill hole, while the borings were backfilled with bentonite-cement grout using a tremie line.

Soil samples were collected at approximately five-foot intervals for laboratory analyses of physical properties. The sampling sequence consisted of augering to the desired sample depth where a 3.0 inch O.D. x 30 inch long Shelby tube would typically be pushed 24 inches to collect a relatively undisturbed soil sample; the Shelby tube samples were trimmed, capped, labeled, and boxed for transport to the Bryte Soils Lab for analysis. Following the push sample, a Standard Penetration Test (SPT) sample was collected by driving a 1.35 inch I.D. by 24 inch long SPT sample barrel

18 inches pursuant to ASTM Standards D 1586 and D 6066. The SPT soil samples were logged by the Engineering Geologist, then bagged and labeled for transport to the Bryte Soils Lab for analysis. Driven samples were collected to a depth of 61.5 feet bgs in both borings drilled at the site.

Groundwater depths were not determined in the borings, as it was necessary to add water during sampling. However, surface water in the adjacent East Borrow Canal was estimated at approximately six feet below the ground surface, or at approximately elevation 37 to 38 feet. The depth to groundwater is probably at the same elevation.

Laboratory Testing of Soils

As mentioned above, relatively undisturbed Shelby tube and disturbed, driven, SPT soil samples were collected for laboratory analyses, at roughly five-foot intervals. Shelby tube samples from both borings were transported to the Department of Water Resources' Bryte Soils Lab for testing. Soil samples from the foundation were proposed for consolidated, undrained, triaxial shear strength testing (CUE), pursuant to ASTM Standard D 4767, as modified by DWR for measuring pore pressure. This testing was requested for sample S-4 from both SW2-1 and SW2-2, collected from 20.0 to 22.0 feet bgs. Two samples from SW2-1 were successfully tested at confining stresses of 1.25 ksc and 2.0 ksc; the third sample collapsed before it could be tested at 0.80 ksc. A substitute sample from the same soil unit (silty sand/poorly graded sand with silt) was tested from sample S-3 (15.0 to 17.0 feet bgs) at 0.80 ksc. As the integrity of the sample was questionable, sample S-3 from SW2-2 (15.0 to 17.0 feet bgs) was used for shear strength testing instead of S-4. All unused Shelby tube samples will be stored at the soils lab for additional analyses, if needed.

A review of the triaxial shear testing data shows that the silty sand/poorly graded sand with silt that makes up the foundation beneath the existing and proposed weir structures are of relatively high strength. An effective strain of 5 percent and a total strain of 10 percent were used for generation of Mohr failure envelope plots of the data; the cohesion and phi values were obtained from three different confining stresses. The drained sample from SW2-1 exhibited a cohesion of c'=1,000 psf and phi=28 degrees, while the undrained sample averaged c=4,000 psf and phi=15 degrees. In the samples from SW2-2, drained cohesion was c'=0 psf and phi=40 degrees, while the undrained samples averaged a cohesion of c=2,500 psf and phi=13 degrees. The triaxial shear testing laboratory reports, data, and plots can be found in Attachment 4.

In addition to shear strength testing, selected samples were also submitted for gradational analysis and determination of Atterberg limits, or plasticity index. Five samples from SW2-1, and four samples from SW2-2 were submitted for gradational/mechanical analysis pursuant to ASTM Standard D 422, and Atterberg limits pursuant to ASTM D 4318; samples that were determined to be non-cohesive were not analyzed for plasticity index determination. Samples selected for gradation and plasticity analyses were based on the depth and occurrence of different soil types encountered in each boring. For boring SW2-1, samples B-1 (7-8.5'), B-3 (17-18.5'), B-5 (26-27.5'), B-7 (36-37.5'), and B-9 (47-48.5') were submitted for gradation and plasticity analysis; the same analyses were requested for samples B-2 (12-13.5') B-3 (17-18.5'), B-4 (22-23.5'), and B-5 (27-28.5') from boring SW2-2. All unused SPT bag samples will be stored at the soils lab for additional analyses, if needed.

Laboratory analyses for gradation and Atterberg limits of the soil samples were completed on September 15, 2003. Attachment 4 shows laboratory classification of soils ranging from a fat clay with a plasticity index of 38 (SW2-2, sample B-4, 22.0-23.5' bgs) to poorly graded sand with silt exhibiting no plasticity (SW2-1, sample B-3, 17.0-18.5' bgs). While the field and laboratory classifications did not always agree, they usually were within one classification of each other; for example, sample B-3 from boring SW2-2 was classified in the field as clayey sand, whereas laboratory testing showed it to be silty sand. The only exceptions to this were sample B-4 from SW2-2, and sample B-1 from SW2-1. Sample B-4, from boring SW2-2, was logged as clayey sand (SC) for the first 12 inches, and lean clay (CL) for the remaining 6 inches; laboratory analysis classified sample B-4 as a fat clay (CH). Sample B-1, from boring SW2-1, was logged as silty sand, while the laboratory classified it as silt with sand. The discrepancy in the field and lab classifications may be the result of heterogeneity within the sample, and/or sample preparation, along with the inherent differences between the classification methods.

Site Geologic Conditions

Weir No. 2, and the surrounding area, are located within Quaternary Alluvium (Qal) soils of the Sacramento Valley. The drill hole logs from both borings drilled as part of this investigation show that soils beneath and adjacent to the existing weir are predominantly lean clay, with lesser amounts of silty sand, clayey sand, and silt (Attachment 3). The invert of the existing structure is at about an elevation of 25 feet. The boring log for SW2-1 shows that the eastern portion of the weir is founded on poorly graded sand with silt to silty sand (SP/SM), while the data from SW2-2 shows that the western side is resting on silty to clayey sand (SM/SC). The subsurface geology of the site is depicted in Cross Section A – A, found on Plate 3.

Left/East Abutment

The geologic log for SW2-1 (Attachment 3), located on the left/east abutment, shows that surface and near-surface soils consist of sandy lean clay to a depth of 7.0 feet bgs, overlying silty sand from 7.0 to 24 feet bgs; laboratory analyses of sample B-1 (7.0-8.5 feet bgs) classified the top of the silty sand unit as a silt with sand, while sample B-3 (17.0-18.5' bgs) from the middle of the unit, and directly above the the proposed and existing weir inverts, was classified as poorly graded sand with silt. Soils beneath the silty sand foundation unit consisted mainly of lean clay with varying amounts of sand (24.0-28.0' bgs, 28.0-44.0' bgs, 49.0-54.0' bgs, and 57.0-61.5' bgs), with lenses of sandy silt (44.0-49.0' bgs), and silty sand (54.0-57.0' bgs). Laboratory analyses of samples B-5 (26.0-27.5' bgs) and B-7 (36.0-37.5' bgs) confirmed them as the sandy lean clay and lean clay they were logged as in the field, while laboratory testing of sample B-9 (47.0-48.5 feet bgs) indicated that the sandy silt logged from 44.0-49.0 feet bgs was actually a silty sand. Uncorrected SPT values for SW2-1 ranged from N=7 (7.5-8.5' bgs) near the surface in silty sand to N=57 (31.0-32.0' bgs) near the middle of the boring in lean clay. The N values show a wide range of soil consistencies, from slightly compact near the surface to very hard at depth. The lithologic descriptions and N values for the left abutment of the weir are depicted on Geologic Section A – A (Plate 3).

The geologic log for boring SB-1, drilled in 1986 as part of the previous weir replacement investigation, showed soils similar to those found in SW2-1. The predominant soil type logged was lean clay, with lenses of clayey sand, silty sand, and silt. SPT values were recorded ranging from N=11 in clayey sand near the surface (5.5-6.5' bgs) to N=96 (25.5-26.5' bgs) in a silty sand around the mid-point depth of the boring. Standard Penetration Test N values in the 1986 boring showed variable soil consistencies ranging from slightly compact to very dense. Generally, the SPT "N" values appeared to be higher in SB-1 than in SW2-1. The drill hole log for SB-1 is contained in Attachment 2 as part of the Project Geology exploration report for a replacement weir.

Right/West Abutment

The lithology of the weir's right/west abutment was logged from boring SW2-2. The soils encountered were primarily lean clay with varying amounts of sand. Near-surface soils consisted of sandy lean clay to a depth of 14.5 feet bgs, overlying a clayey sand extending to 23.0 feet bgs; laboratory classification of a sample (B-2, 12.0-13.5' bgs) from the base of the sandy lean clay indicated it was a silt, while one sample (B-3, 17.0-18.5' bgs) from the clayey sand was classified as silty sand. Soils beneath the clayey sand foundation of the weir consisted primarily of lean clay with varying amounts of sand (23.0-32.0' bgs, 37.0-46.0' bgs, and 52.0-61.5' bgs) and lean clay with clayey sand lenses (32.0-37.0' bgs and 46.0-52.0' bgs). However, laboratory classification of sample B-4 (22.0-23.5' bgs) showed that the base of the clayey sand, and the top of the underlying lean clay, was actually a fat clay; laboratory analyses of sample B-5 (27.0-28.5' bgs) indicated that it was silt, instead of the lean clay it was logged as in the field. Boring SW2-2 exhibited uncorrected SPT values ranging from N=1 (7.5-8.5' bgs) in near-surface sandy clay to N=48 (47.5-48.5' bgs) for a clayey sand 14 feet from the bottom of the boring. The N values show a very wide range of soil consistencies, from very soft near the surface to dense at depth. Lithologic descriptions and SPT values are shown on the drill hole logs (Attachment 2) and on Geologic Section A – A, shown on Plate 3.

The geologic log for boring SB-2, also drilled in 1986 as part of the previous weir replacement investigation (Attachment 2), showed predominantly fine-grained soils similar to those found in SW2-2. The primary soil type logged was lean clay, with lenses of clayey sand and silty sand; however, unlike any of the other borings, SB-2 contained poorly graded sand from the surface to eight feet bgs. SPT values were recorded ranging from N=2 near the surface (9.5-10.5' bgs) in clayey sand to N=90+ (25.5-26.5' bgs) also in a clayey sand just above the mid-point depth of the boring. Uncorrected Standard Penetration Test N values in the 1986 boring showed widely variable soil consistencies ranging from very loose to very dense. Generally, the SPT "N" values appeared to be higher in SB-2, than in SW2-2.

New Weir Foundation Conditions

In conversations between you and Brent, and in a proposed weir profile you provided to Tim Todd, you indicated that the invert of the proposed weir will be at approximately elevation 26 feet, with a concrete slab footing extending about 2 feet deeper, or elevation 24 feet. At that elevation, the new weir will be founded on poorly graded sand with silt to silty sand (SW2-1) and silty to clayey sand (SW2-2). Both foundation soil types extend below the proposed foundation an additional four feet, where they overlie lean clay soils in SW2-1 and silt, lean clay, and some fat clay in SW2-2 (Plate 3 and Attachment 3). Uncorrected SPT blow counts of N=32 (elevation 25.5 to 26.5') for SW2-1, and N=19 (elevation 24.5 to 25.5') for SW2-2 were measured within the upper foundation of the proposed weir structure, and show the soils to be compact to dense. Uncorrected SPT values for the next interval tested in the foundation soils were N=13 (elevation 20.5 to 21.5') for SW2-1, and N=24 (elevation

19.5 to 20.5') in SW2-2, exhibiting consistencies ranging from slightly compact to hard/dense. The underlying, very hard, lean clay unit exhibited higher SPT values of N=46 (26.5-27.5' bgs) in SW2-1, and N=43 (27.5-28.5' bgs) in SW2-2.

Triaxial shear testing of the silty sand foundation soils showed them to be of high strength, with undrained cohesion values of c=2,500 to 4,000 psf, and phi angles ranging from 13 to 15 degrees; drained cohesion values ranged from c'=0 to 1,000 psf, and phi values of 28 to 40 degrees. The uncorrected SPT N values appear to correspond well with the triaxial shear test data, especially in SW2-1, where uncorrected blow counts of N=32 were recorded at elevation 25.5 to 27.0 feet; the same elevation in SW2-2 exhibited an uncorrected value of N=19.

Conclusions and Recommendations

- The proposed weir structure will be founded on clayey sands and silty sand Quaternary alluvium soils, replacing the existing structure at the same location. Foundation soils at the site have performed well during the life of the existing structure, and were found to be suitable for supporting the proposed structure; they are also very suitable for driving piles for additional support, if needed. Some of the SPT values recorded in the two soil borings at and immediately below the proposed weir invert were relatively low for a spread footing foundation. However, N values for the same elevations beneath the existing and proposed weirs are expected to be higher because of consolidation and loading from the existing structure for over 75 years. While the existing structure has not exhibited any foundation problems, it may be desirable to move the invert of the slab/spread footing foundation from the currently proposed elevation of 26 feet to an elevation of 20 feet. At an elevation of 20 feet, the structure will be founded on a very hard, lean clay with uncorrected SPT values of N=43 to N=46; this would lesson the likelihood of settlement and/or liquefaction during a seismic event. The same result could also be accomplished with a pile-supported, or reinforced, foundation.

- While groundwater elevations were not determined during this investigation, they can be assumed to coincide with surface water levels in the adjacent East Borrow Canal, at approximately elevation 37 feet. Therefore, groundwater should be anticipated in excavations at or below that elevation. Dewatering will be required in and/or around the demolition of the existing structure, and excavations and construction of the replacement weir. As the canal is continuously filled with water, and the clayey soils may not drain well, any dewatering for construction should be done in stages to prevent possible pore-pressure-induced slope failures.

- The materials at the site can be excavated using common methods and equipment. The presence of groundwater in the weir foundation soils may impact the selection of the equipment to be used. As the shallow abutment soils were relatively soft, and exhibited relatively low N values, some support may be required to stabilize the abutments during demolition and foundation preparation, especially at the right abutment. Sheet piles may be the best method for temporarily supporting the exposed abutments prior to and during construction of the new weir structure.

- An engineering geologist from DWR should make periodic inspections during construction to record the geologic conditions encountered.

Thank you for the opportunity to assist you with this project. If you have any questions, or need additional information, please contact me at (916) 323-8928, or Brent Lamkin at (916) 323-8925.

Attachments

cc: Ron Lee

ATTACHMENTS

ATTACHMENT 1

2002 Weir No. 2 Structural Analysis Report

State of California

The Resources Agency

Memorandum

Date: OCT 25 2002

To: William McLaughlin, Associate Engineer
Northern District

Timothy Talbert, Sr. Structural Specialist
Division of Engineering

From: Department of Water Resources

Subject: Weir No. 2 Structural Evaluation

Introduction

On August 9, 2002, you requested that the Division of Engineering, Structures Section perform an evaluation of Weir No. 2, which is located in the East Borrow Canal of the Sutter Bypass. You indicated that a new fish ladder is being proposed to replace an existing, poorly functioning fish ladder at the weir structure and that there are general concerns regarding the integrity of the structure's foundation. You also indicated that past flow measurements at the weir and just downstream of the weir indicate that seepage under the foundation may be significant.

This memorandum transmits the results of the Structures Section's evaluation, which includes an assessment of the current condition of the weir structure, constructability of a new fish ladder, and recommendations for the current weir structure. The evaluation is based on a review of engineering drawings and two site inspections.

Weir Structure Description

The weir structure consists of a reinforced concrete apron, 11 reinforced concrete piers, and a concrete steppool fish ladder incorporated into the west abutment. The concrete apron, originally constructed in 1925, is 104 feet long, 35 feet wide and four inches thick. Sheet pile cutoff walls are integrated into the apron at its upstream and downstream edges. The apron and cutoff walls form the foundation for the weir structure. The concrete piers, approximately 12-1/2 feet tall, were constructed in 1946 to replace a timber flashboard-type dam built as part of the original structure. The piers provide support for removable timber flashboards. The flashboards are in place during the spring, summer and fall to increase water depth within the canal upstream of the weir structure, which is necessary for the Sutter National Wildlife Refuge and agricultural water diversions. The flashboards are removed in the winter to allow for passage of high canal flows.

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10/25/02

Site Inspections

I inspected the site on August 15, 2002. On this day, the weir flashboards were in place and water was flowing over the top flashboard in each of the 12 bays. The water depths were approximately 10 feet on the upstream side of the flashboards and three feet on the downstream side. The weir structure visible (above water) appeared to be in good condition with no signs of deterioration. Since the condition of the submerged portion of the structure could not be adequately assessed, an underwater inspection of the structure was scheduled to investigate a known hole in the concrete floor (found previously by a Northern District survey crew).

On September 12, 2002, an underwater inspection of the weir was conducted. In order to perform this inspection, it was necessary to reduce the flow through the weir structure as much as possible. To accomplish this, Flood Management – Sutter Maintenance Yard staff removed all of the weir's flashboards the day before the inspection and then replaced them just prior to divers entering the water. This reduced the flow to the amount of leakage between the flashboards; there was no flow over the top of the flashboards. The inspection revealed the following:

- Concrete apron is heavily worn and aggregate is exposed.
- Three holes were found in the concrete apron:
    - The first hole, approximately 2 feet in diameter, is located in the third bay from the west bank of the structure. The concrete edges around the opening were rounded and the reinforcing steel was mostly intact. There is a large void beneath the apron at this location. The void measured 7 to 9 feet deep by 13 to 16 feet in diameter.
    - The second hole is also located in the third bay from the west bank of the structure. This hole is 1-1/2 to 2 feet in diameter with a 1-foot deep void beneath the apron. This hole is near the downstream edge of the apron.
    - The third hole is located in the first bay from the west bank of the structure. This hole is 1-1/2 to 2 feet in diameter with a 1 to 2-foot deep void beneath the apron.
- At the downstream edge of the apron, the depth to soil from top of concrete varies from 1-1/2 feet on the east side to 3 feet on the west side.

- At the downstream edge of the apron, approximately 20 feet from the west abutment, a hole in the cutoff wall and an adjoining void were located beneath the apron. The void measured approximately 7 feet long in the direction of flow, and 1 to 2 feet wide.

- On top of the apron, near the fourth bay from the west side, there is a 3 to 4-foot diameter by 6 to 10-inch high mound of concrete or possibly asphalt.

- Rocks up to 9 inches in diameter were found on the apron floor within several bays.

The attached drawing shows the findings of the underwater inspection.

<u>Conclusions</u>

The weir's foundation, which includes the concrete apron and cutoff walls, shows signs of significant deterioration, while the concrete piers and abutments appear to be in good condition. Without corrective actions, this deterioration will continue until foundation failure occurs, which would likely render the weir structure inoperable. The following are important areas of concern:

- Significant damage to concrete apron - The apron is extremely worn and in three locations the concrete has completely worn away, allowing the underlying soil to erode. In the worst location, the third bay from the west abutment, the erosion has lead to significant undermining of the apron and a concrete pier. Failure of the apron at this location could cause the supported pier to topple, rendering the weir structure inoperable.

- Seepage through cutoff wall - There is a hole in the downstream cutoff wall along with an adjoining void. This indicates that seepage does occur and that the seepage is sufficient to erode the underling soil. In addition, given the age of the cutoff wall, it is probable that other holes exist.

- Extent of undermining is unknown, but appears to be significant - Given the defects in the apron and cutoff wall and the likelihood of additional undetected defects, it is probable that the extent of undermining is much worse than the weir inspections reveal.

New Fish Ladder Constructability

Replacing the existing Weir No. 2 fish ladder with a new fish ladder is possible. Based on Northern District's preliminary concepts for a new fish ladder, the work would include the following:

- Dewater the work site - likely using earthen coffer dams located upstream and downstream of the weir structure.
- Demolish the existing fish ladder and two to three eastern weir bays.
- Excavate foundation.
- Replace the existing fish ladder with new weir bays.
- Replace the two to three weir bays near the east abutment with a new fish ladder.

An operational fish ladder at this location requires an operational weir. Constructing a new fish ladder designed to operate for 30 or more years requires that the weir be operational for the same period of time. The options to achieve this level of weir service are to improve the existing weir structure or replace it.

Significant cost savings could be achieved if weir improvements coincide with the replacement of the fish ladder: dewatering and mobilization costs would be avoided along with other economies of scale savings, including inspection and contract administration costs savings. Therefore, for the purpose of this evaluation, it is assumed that any weir improvement work would coincide with fish ladder replacement.

Minimum weir improvements necessary for an adequate service life include:

- Coring and grouting concrete apron to eliminate voids.
- Reconstructing upstream and downstream seepage cutoff walls.
- Covering the entire apron with a wear layer of high-strength concrete.
- Placing riprap to prevent erosion at downstream edge of apron.
- Replacing the access platform with a safe, all-weather access platform.

Replacing the weir with a structure meeting current design standards would guarantee a sound structure and allow for operational improvements. The current method for removing and installing flashboards are labor intensive. A new weir structure could include features to ease flashboard removal and installation. Construction of a replacement weir would include:

- Demolition of weir structure.
- Construction of upstream and downstream cutoff walls, concrete apron, and concrete piers. The east abutment appears sound and likely would remain in place.
- Construction of an access platform.
- Installation of flashboard/bulkhead lifting device or use of a boom truck or crane.

Assuming that funding is available for either option at the time the new fish ladder is constructed, I recommend that the weir structure be replaced. The amount of work required to replace the weir is not significantly more than that required to improve the existing weir and there are additional safety and operational benefits.

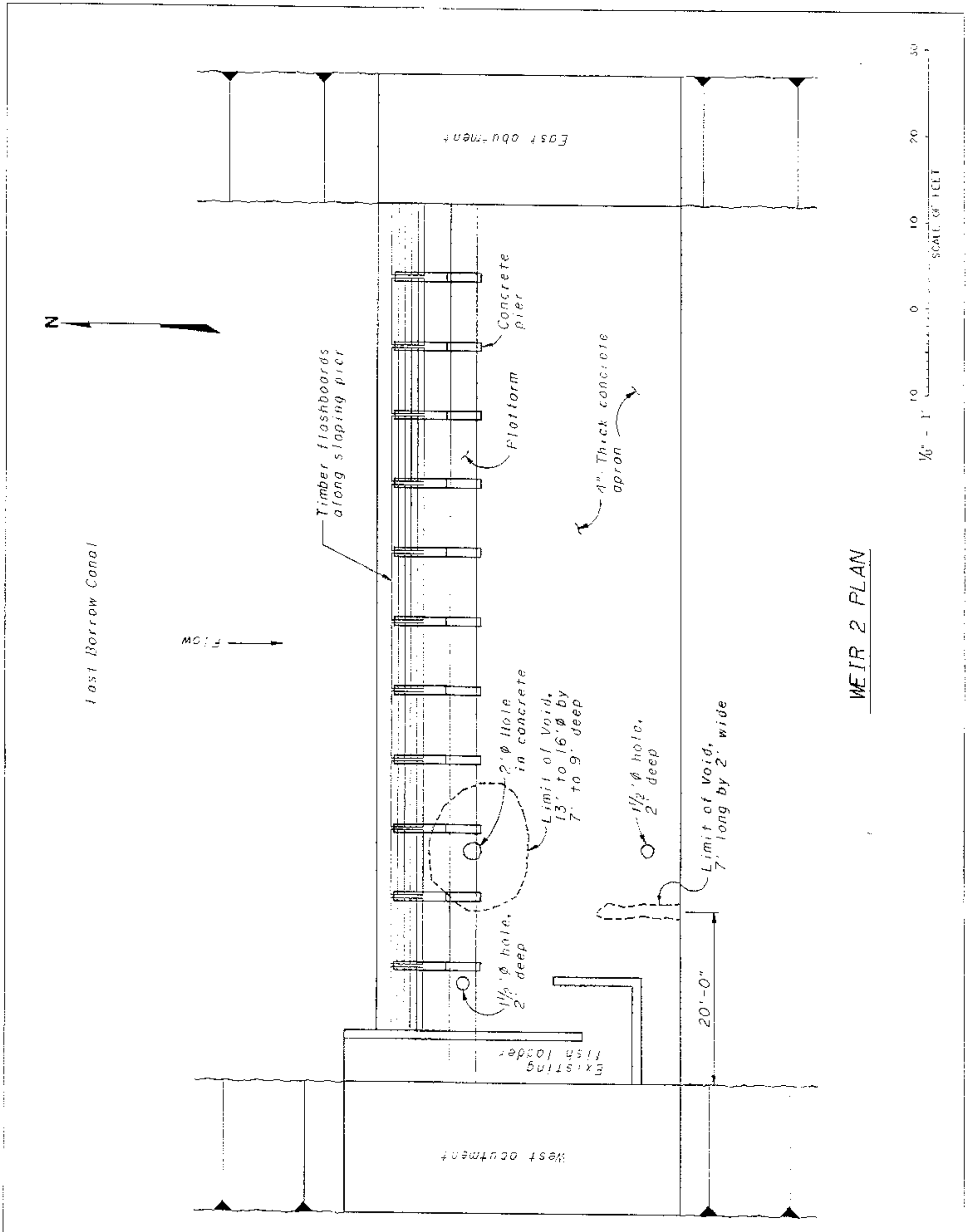
Recommendations for Current Weir Structure

The weir site inspections revealed signs of significant structural deterioration. In order to prevent further deterioration and possible structural failure, I recommend that the following actions be taken as soon as possible:

- Fill all known voids with concrete to prevent further soil erosion and apron undermining.
- Re-inspect weir apron by sealing flashboards with plastic so that seepage through the flashboards is minimized. This will allow a more complete investigation of the apron and possibly allow detection of seepage under the apron.
- Institute a weir inspection plan that includes thorough periodic inspections of the apron. The apron has worn completely away in three areas and will likely wear away in other areas. When new holes are found, they should be filled with concrete as soon as possible.

These actions should be considered an intermediate fix until the weir structure is either replaced or significantly improved. The weir foundation consists of a nearly 80-year-old concrete apron connected to steel sheet pile cutoff walls. This foundation is significantly deteriorated and will continue to deteriorate until more permanent improvements can be made.

cc: J. Schallberger, DOE, Rm. 313-B, Bonderson
C. Diaz, DOE, Rm. 313-A, Bonderson
K. Swanson, DOFM, Rm. 114
K. Dickerson, DOFM, Sutter Maintenance Yard


WEIR 2 PLAN
1/8" = 1'
SCALE OF FEET
10 0 10 20 30
N
East Borrow Canal
Flow
East abutment
West abutment
Timber flashboards along sloping pier
Concrete pier
Platform
4" Thick concrete apron
2'ø Hole in concrete
Limit of Void, 13' to 16'ø by 7' to 9' deep
1½'ø hole, 2' deep
Limit of Void, 7' long by 2' wide
1½'ø hole, 2' deep
20'-0"
Existing fish ladder

ATTACHMENT 2

1986 Project Geology Exploration Report for the Proposed Weir No. 2 Replacement Structure

State of California   The Resources Agency

Memorandum

Date : May 29, 1986

To : Donald Steinwert

Attention: Jack Garber

From : Mark McQuilkin
Department of Water Resources

Subject : Sutter Bypass, Exploration Borings for Proposed Weir #2

The Project Geology Branch investigated foundation conditions at the site of the new Sutter Bypass Weir #2 in Sutter County on April 29, 30, and May 1, 1986. This exploration was requested by Dale Martfeld of the DWR Civil Design Branch and was discussed in Project Geology Branch exploration proposal dated February 26, 1985. Drilling and sampling, contracted to Hogate Exploration Drilling Company of Citrus Heights, was performed under the direction of DWR Engineering Geologist, Robert Conover.

Figure 1 is a plan view showing the locations of the borings. Figure 2 is a section showing the soil types, N-value and sampled intervals for the Standard Penetration Test (SPT). Appendix A contains the logs of the borings.

The exploration consisted of drilling two borings to depths of 51.5 feet (SB-1) and 61.5 feet (SB-2) and performing Standard Penetration Tests (ASTM D-1586) at approximate five-foot intervals. Five undisturbed Shelby samples were also obtained.

Upon completion of drilling, the holes were backfilled by pumping a cement-bentonite mixture through a tremie pipe. Hole locations and elevations were surveyed by personnel of the Division of Land and Right of Way.

Drilling and Sampling

Sutter Bypass Weir #2 is to be located across the existing East Borrow Pit of the Sutter Bypass. The new weir will be constructed approximately 100 feet south of the existing weir, just north of the intersection of McClatchy Road and the East Levee Road (SW1/4,S33,T14N,R2E Mount Diablo Base and Meridian). The abutment material is alluvial soils, primarily clayey sands, and clay. Drilling was accomplished using rotary wash drilling procedures. Standard Penetration testing was performed by driving a two-inch split-barrel sampler with a 1-3/8 inch inside diameter with a safety type slide hammer, using the rope and cathead procedure. Soil types were classified in the field, and soil samples were bagged and returned to Sacramento for examination. Five three-inch diameter Shelby tube samples of clayey soils were recovered and are stored at the Bryte Lab.

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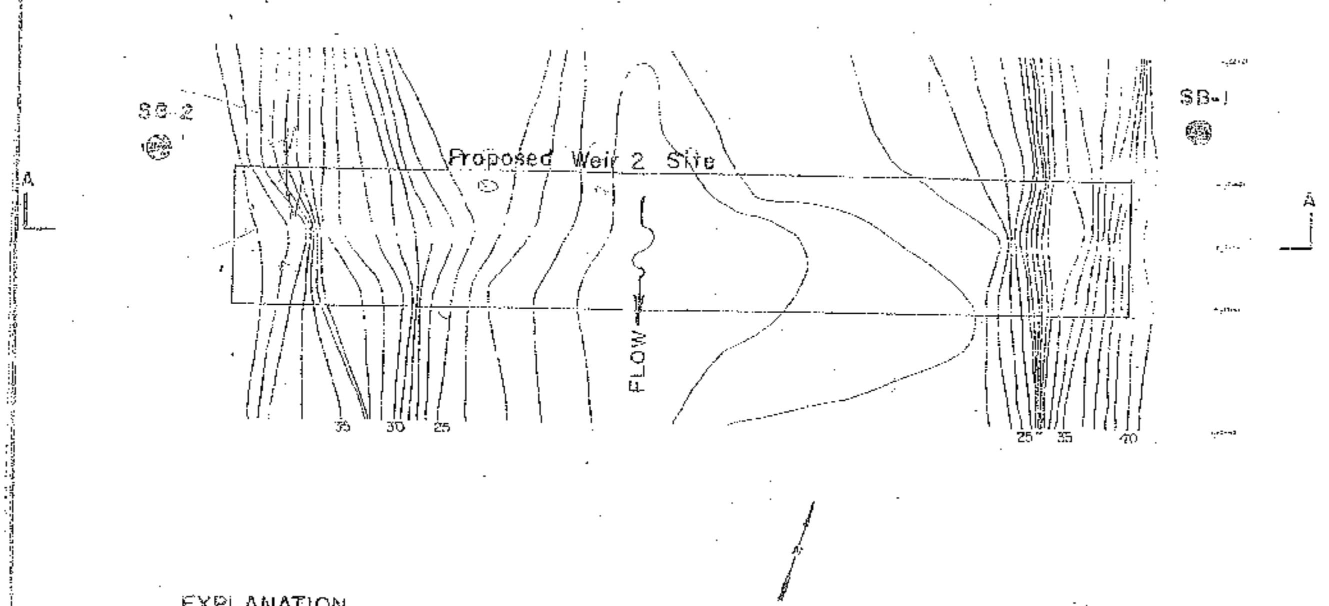


EXPLANATION

DWR DRILL HOLE: Location and number

A A LINE OF GEOLOGIC CROSS SECTION

SCALE

20 10 0 10 20 30 40

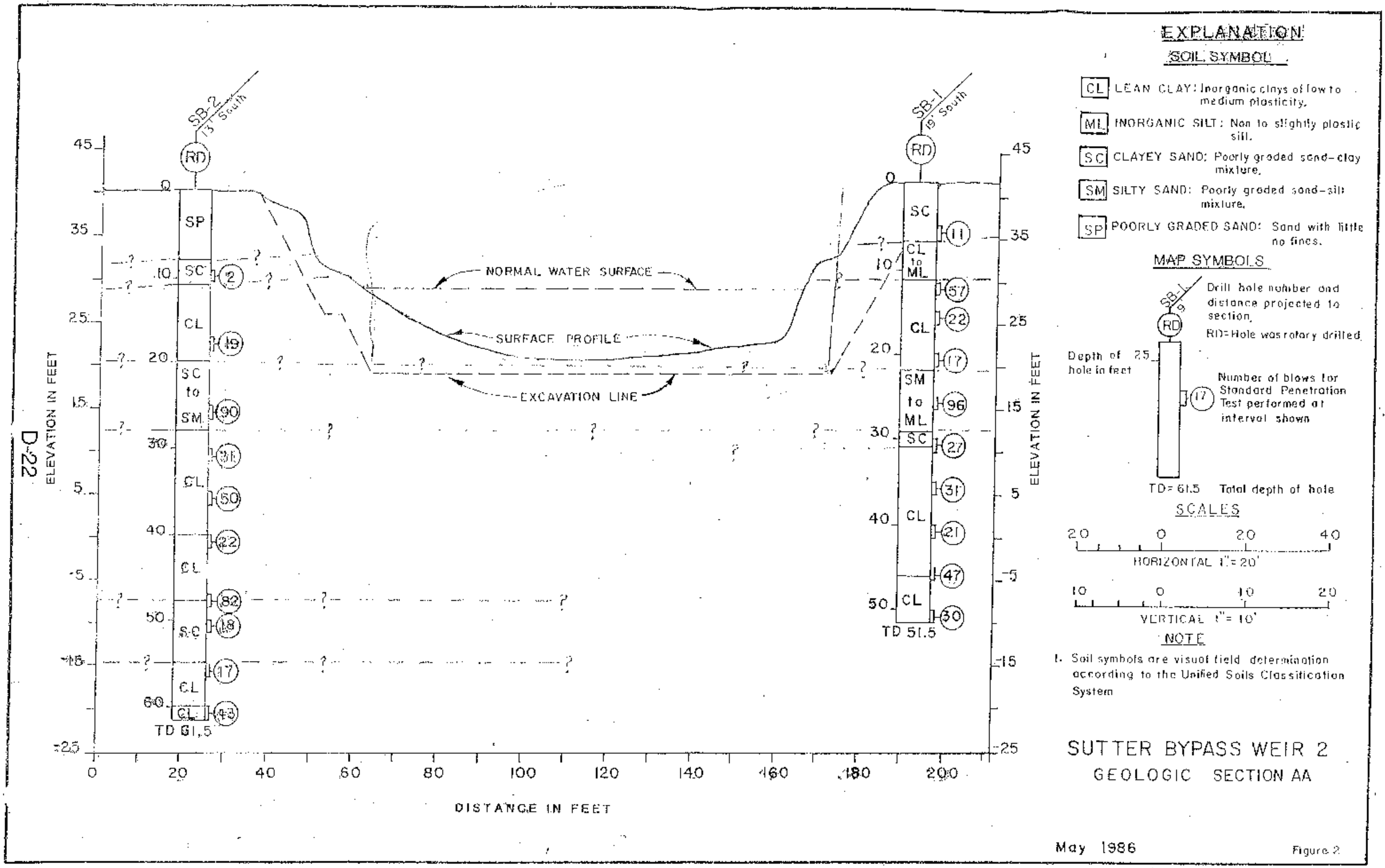
SCALE IN FEET

CONTOUR INTERVAL: 1'

SUTTER BYPASS WEIR 2
PLAN VIEW
GEOLOGIC SECTION A A

May 1986

Figure 4


SB-2 13' South
RD
SP
SC
CL
SC to SM
CL
CL
SC
CL
CL
TD 61.5
2
19
90
31
50
22
82
18
17
43
SB-1 19' South
RD
SC
CL to ML
CL
SM to ML
SC
CL
CL
TD 51.5
11
57
22
17
96
27
31
21
47
30
NORMAL WATER SURFACE
SURFACE PROFILE
EXCAVATION LINE
ELEVATION IN FEET
DISTANCE IN FEET
EXPLANATION
SOIL SYMBOL
CL LEAN CLAY: Inorganic clays of low to medium plasticity.
ML INORGANIC SILT: Non to slightly plastic silt.
SC CLAYEY SAND: Poorly graded sand-clay mixture.
SM SILTY SAND: Poorly graded sand-silt mixture.
SP POORLY GRADED SAND: Sand with little no fines.
MAP SYMBOLS
Drill hole number and distance projected to section.
RD=Hole was rotary drilled.
Depth of hole in feet
Number of blows for Standard Penetration Test performed at interval shown
TD=61.5 Total depth of hole
SCALES
HORIZONTAL 1"=20'
VERTICAL 1"=10'
NOTE
1. Soil symbols are visual field determination according to the Unified Soils Classification System
SUTTER BYPASS WEIR 2
GEOLOGIC SECTION AA
May 1986
Figure 2

ATTACHMENT 3

Weir No. 2, 2003 Exploration Drill Hole Logs

State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES

DRILL HOLE LOG

SHEET 1 of 4
HOLE NO. SW2-1
ELEV. 44 (topo.) FEET
DEPTH 61.5 FEET
DATE DRILLED 6/24/2003
ATTITUDE Vertical
LOGGED BY T. Todd
DEPTH TO WATER Not Determined

PROJECT Sutter Bypass Improvements
FEATURE Weir No. 2
LOCATION N. 25,290,546 E. 6,204,442; East/Left Abutment
CONTR. Spectrum Exploration DRILL RIG CME 85

DR- Standard Penetration Test
P- Push
B- Bag Sample
NS- No Sample
S- Shelby Tube
AD- Auger Drilling
PP- Pocket Penetrometer
SV- Shear Vane
RD- Mud Rotary Drilling

DEPTH (ELEV.)	LOG	FIELD CLASSIFICATION AND DESCRIPTION	SAMPLE NO.	MODE	REMARKS
0.0	Road	ROAD BED 0.0 to 0.5' Gravel Road Bed		AD	Drilling with augers.
	s(CL)	RECENT ALLUVIUM 0.0 to 61.5'			Drill Rate: 5.0' in 3 min.
2.0		0.5 to 7.0' Sandy clay, s(CL): About 60% low to medium plasticity clay; about 40% mostly fine sand; damp; stiff; yellowish brown.			
4.0 (40.0')					
6.0	s(CL)	Silty Clay.	S-1	P	5.0 - 7.0' Shelby Tube Drive Recovered:2.0'
8.0	SM	7.0 to 24.0' Silty Sand, (SM): About 70% fine to medium sand; about 20% nonplastic fines; trace clay; moist; loose to slightly compact; olive brown.	B-1	DR	7.0 - 8.5' SPT Drive: 0/1/6 N=7 Recovered: 1.5'
				AD	Easy drilling
10.0			S-2	P	10.0 - 12.0' Shelby Tube Push Recovered: 2.0'
12.0			B-2	DR	12.0 - 13.5' SPT Drive: 1/4/6 N=10 Recovered: 1.5'
14.0 (30.0')	SM	Loose to slightly compact.		AD	Drill Rate: 1 min.
16.0			S-3	P	15.0 - 17.0' Shelby Tube Push Recovered: 2.0'

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State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES
DRILL HOLE LOG

SHEET 2 of 4
HOLE NO. SW2-1

PROJECT & FEATURE Sutter Bypass Improvements, Weir No. 2

DEPTH (ELEV.)	LOG	FIELD CLASSIFICATION AND DESCRIPTION	SAMPLE NO.	MODE	REMARKS
16.0	SM	RECENT ALLUVUM 0.5 to 61.5'	S-3	P	15.0-17.0' Shelby tube push con Recovered: 2.0'
18.0		7.0 to 24.0' Silty Sand, (SM): cont. About 70% fine to medium sand; about 30% nonplastic fines; moist; slightly compact; olive brown.	B-3	DR	17.0 - 18.5' SPT Drive: 6/12/20 N= 32 Recovery: 1.5'
		80% sand; 20% nonplastic fines.		AD	Drilling with augers Sand running
20.0			S-4	P	20.0 - 22.0' Shelby tube push Recovery: 2.0'
22.0	SM	About 80% fine to medium sand; about 20% nonplastic fines; moist; slightly compact; olive brown.	B-4	DR	22.0 - 23.5' SPT Drive: 3/6/7 N= 13 Recovered: 1.5'
24.0 (20.0')	s(CL)	24.0 to 28.0' Sandy Lean Clay, s(CL): About 80% low to medium plasticity clay; about 20% fine sand; trace nonplastic fines; damp; hard to very hard; mostly yellow brown with some buff.		AD	
			S-5	P	25.0 - 26.0' Shelby tube push Recovered: 1.0'
26.0	s(CL)		B-5	DR	26.0 - 27.5' SPT Drive: 21/21/25 N=46 Recovered: 1.5'
28.0	CL	28.0 to 44.0' Lean Clay, (CL): Mostly low to medium plasticity clay; trace nonplastic fines; damp; hard to very hard; buff to light brown.		AD	Steady drilling.
30.0 (14)			S-6	P	30.0' lost shelby, moved hole 4'. 30.0 - 30.5' Shelby tube push Recovered: 0.5'
			B-6	DR	30.5 - 32.0' SPT Drive: 10/27/30 N= 57 Recovered: 1.5'
32.0				AD	
34.0 (10.0')	CL				
			S-7	P	35.0 - 36.0' Shelby tube push Recovered: 1.0'
36.0					

DWR 885 (2) (Rev. 9-84)

State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES
DRILL HOLE LOG

SHEET 3 of 4
HOLE NO. SW2-1

PROJECT & FEATURE Sutter Bypass Improvements, Weir No. 2

DEPTH (ELEV.)	LOG	FIELD CLASSIFICATION AND DESCRIPTION	SAMPLE NO.	MODE	REMARKS
36.0	CL	RECENT ALLUVIUM 0.5 to 61.5' 28.0 to 44.0' Lean Clay, (CL): cont.	B-7	DR	36.0 - 37.5' SPT Drive: 4/9/11 N= 20 Recovery: 1.5'
38.0		Mostly low to medium plasticity clay; trace nonplastic fines; damp; hard; buff to light brown.		AD	Drilling with augers. Steady drilling Drill rate: 2 min.
40.0		39.0 to 41.0' Clayey sand layer; olive lean clay, low to medium plasticity clay; damp; hard to very hard; buff to light brown.	S-8	P	40.0 - 41.0' Shelby tube push Recovery: 1.0'
42.0	CL		B-8	DR	41.0 - 42.5' SPT SPT Drive: 8/11/16 N= 32 Recovery: 1.5'
				AD	steady drilling Drill rate: 2 min
44.0 (0')	s(ML)	44.0 to 49.0' Sandy Silt, s(ML): About 70% nonplastic fines (silt); about 30% fine sand; trace clay; moist; loose to slightly compact; yelow brown with some reddish mottling.			
46.0			S-9	P	45.0 - 47.0' Shelby tube push Recovered: 2.0'
48.0	s(ML)		B-9	DR	47.0 - 48.5' SPT Drive: 3/5/8 N= 13 Recovered: 2.0'
				AD	
	CL	49.0 to 54.0' Lean Clay, (CL): Mostly low to medium plasticity clay; trace silt; damp; hard to very hard; olive brown.			
50.0			S-10	P	50.0 - 52.0' Shelby tube push Recovered: 2.0'
52.0	CL		B-10	DR	52.0 - 53.5' SPT Drive: 5/15/18 N= 33 Recovered: 1.5'
54.0 (-10')	SM	54.0 to 57.0' Silty Sand, (SM): About 70% fine to medium sand; about 30% nonplastic fines.		AD	
56.0			S-11	P	55.0 - 57.0' Shelby tube push Recovered: 2.0'

DWR 885 (2) (Rev. 9-84)

State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES
DRILL HOLE LOG

SHEET 4 of 4
HOLE NO. SW2-1

PROJECT & FEATURE Sutter Bypass Improvements, Weir No. 2

DEPTH (ELEV.)	LOG	FIELD CLASSIFICATION AND DESCRIPTION	SAMPLE NO.	MODE	REMARKS
56.0	SM	RECENT ALLUVIUM 0.5 to 61.5' 54.0 to 57.0' Silty Sand. (SM): cont. Moist; loose to slightly compat; olive brown.	S-11	P	55.0 - 57.0' shelby push cont. Recovered: 2.0'
58.0	CL	57.0 to 61.5' Silty Lean Clay, (CL): About 60% low to medium plasticity clay; about 40% nonplastic fines (silt); moist; stiff; yellow brown to olive brown. Grades to silt.	B-11	DR	57.0 - 58.5' SPT SPT Drive: 1/2/7 N= 9 Recovered: 1.5'
				AD	
60.0	CL		B-12	DR	60.0 - 61.5' SPT SPT Drive: 5/13/11 N= 24 Recovered: 1.5'
62.0 (-18')		Total Depth - 61.5'			Grouted hole with bentonite-cement grout using a tremie pipe.

DWR 865 (2) (Rev. 9-84)

State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES

DRILL HOLE LOG

SHEET 1 of 4
HOLE NO. SW2-2
ELEV. 43 (topo.) FEET
DEPTH 61.5 FEET
DATE DRILLED 6/23/2003
ATTITUDE Vertical
LOGGED BY T. Todd
DEPTH TO WATER Not Determined

PROJECT Sutter Bypass Improvements
FEATURE Weir No. 2
LOCATION N. 25,290,466 E. 6,204,265; West/Right Abutment
CONTR. Spectrum Exploration DRILL RIG CME 85

DR- Standard Penetration Test
P- Push
B- Bag Sample
NS- No Sample
S- Shelby Tube
AD- Auger Drilling
PP- Pocket Penetrometer
SV- Shear Vane
RD- Mud Rotary Drilling

DEPTH (ELEV.)	LOG	FIELD CLASSIFICATION AND DESCRIPTION	SAMPLE NO.	MODE	REMARKS
0.0	s(CL)	RECENT ALLUVIUM 0 to 61.5' 0.0 to 14.5' Sandy Lean Clay, s(CL): About 70% low to medium plasticity clay; about 30% fine sand; very soft to soft; damp; olive brown.		AD	Drilling with hollow stem augers. Drilling rate: 1.5 min. Easy drilling
2.0					
(40')					
4.0					
6.0			S-1	P	5.0' - 7.0' Shelby Tube push Recovered: 2.0'
	s(CL)	About 60% clay; about 40% fine sand; olive; trace fine, rounded gravel.			
8.0			B-1	DR	7.0 - 8.5' SPT Drive: 0/0/1 N=1 Recovered: 1.5'
				AD	Easy drilling
10.0			S-2	P	10.0 - 12.0' Shelby Tube Push Recovered: 2.0'
12.0					
(30')	s(CL)	About 60% clay; about 40% fine sand; yellow brown; stiff to very stiff.	B-2	DR	12.0 - 13.5' SPT Drive: 3/5/7 N= 12 Recovered: 1.5'
14.0				AD	
	SC	14.5 to 23.0' Clayey Sand, (SC): About 60% fine sand; about 40% low to medium plasticity clay; slightly compact; olive gray; damp with clay layers.	S-3	P	15.0 - 17.0' Shelby Tube Push Recovered: 2.0'
16.0					

DWR 885 (1) (Rev. 9-84)

SHEET 2 of 4
HOLE NO. SW2-2

DRILL HOLE LOG

PROJECT & FEATURE Sutter Bypass Improvements, Weir No. 2

DEPTH (ELEV.)	LOG	FIELD CLASSIFICATION AND DESCRIPTION	SAMPLE NO.	MODE	REMARKS
16.0	SC	RECENT ALLUVUM 0 to 61.5' 14.5 to 23.0' Clayey Sand, (SC): cont. Slightly compact; olive gray; damp; with clay layers.	S-3	P	15.0 - 17.0' Shelby push cont. Recovered: 2.0
18.0			B-3	DR	17.0 - 18.5' SPT Drive: 3/7/12 N= 19 Recovered: 1.5'
				AD	Easy drilling
20.0			S-4	P	20.0 - 22.0' Shelby tube push Recovered: 2.0'
	SC				
22.0			B-4	DR	22.0 - 23.5' SPT Drive: 4/9/15 N= 24 Recovered: 1.5'
(20')	CL	23.0 to 32.0' Lean Clay, (CL): Mostly low to medium plasticity clay; some nonplastic fines; trace fine sand; damp; very stiff to hard; yellowish brown.			
24.0				AD	
26.0				P	25.0 - 27.0' Shelby tube push Recovered: 0, tube crushed
28.0			B-5	DR	27.0 - 28.5' SPT Drive: 10/21/22 N= 43 Recovered: 1.5'
		Low to medium plasticity clay; some nonplastic fines; white and orange motting; damp; very hard; yellowish brown.		AD	Drill Rate: 4 minutes
30.0	CL		S-5	P	30.0 - 32.0' Shelby tube push Recovered: 2.0', tip of tube crushed.
32.0	SC	32.0 to 37.0' Clayey Sand, (SC): About 70% fine sand; about 30% low clay; damp; compact; yellowish brown.	B-6	DR	32.0 - 33.5' SPT Drive: 4/9/15 N= 24 Recovered: 1.5'
(10')					
34.0				AD	Steady drilling
	SC		S-6	P	35.0 - 37.5' Shelby tube push Recovered: 2.5'
36.0					

DWR 885 (2) (Rev. 9-84)

State of California
The Resources Agency

SHEET 3 of 4

DEPARTMENT OF WATER RESOURCES

DRILL HOLE LOG

HOLE NO. SW2-2

PROJECT & FEATURE Sutter Bypass Improvements, Weir No. 2

DEPTH (ELEV.)	LOG	FIELD CLASSIFICATION AND DESCRIPTION	SAMPLE NO.	MODE	REMARKS
36.0	SC	RECENT ALLUVIUM 0 to 61.5' 32.0 to 37.0' <u>Clayey Sand, (SC)</u>: cont. About 70% fine sand; about 30% low to medium plasticity clay; damp; compact; yellowish brown.	S-6	P	35.0 - 37.5' Shelby push cont. PP >4 tsf Recovered: 2.5'
38.0	(CL)s	37.0 to 46.0' <u>Lean Clay with Sand, (CL)s</u>: About 80% low to medium plasticity clay; about 20% fine sand; hard to very hard; damp; olive gray.	B-7	DR	37.5 - 39.0' SPT SPT Drive: 8/15/27 N= 42 Recovered: 1.5'
				AD	Drill rate: 4 min.
40.0			S-7	P	40.0 - 42.0' Shelby tube push Recovered: 1.5' 550 psi push, rig lifted up
42.0 (0')			B-8	DR	42.0 - 43.5' SPT SPT Drive: 6/7/10 N= 17 Recovered: 1.5'
44.0	(CL)s			AD	Drill rate: 3 min.
			S-8	P	45.0 - 47.0' Shelby tube push Recovered: 1.5' 550 psi push, hard.
46.0	SC	46.0 to 52.0' <u>Clayey Sand, (SC)</u>: About 80% mostly fine sand; about 20% clay; trace nonplastic fines; moist; dense to very dense; olive brown; thin lamanations at 1/8" thick dipping at 15 degrees.	B-9	DR	47.0 - 48.5' SPT Drive: 12/28/20 N= 48 Recovered: 1.5'
48.0				AD	Drill rate: 3 min.
50.0	SC		S-9	P	50.0 - 52.5' Shelby tube push Recovered: 2.5'
52.0 (-10')	CL	52.0 to 61.5' <u>Lean Clay, (CL)</u>: Mostly low to medium plasticity clay; trace fine sand; damp; very hard; light brown to buff.	B-10	DR	52.5 - 54.0' SPT SPT Drive: 5/12/28 N= 40 Recovered: 1.5'
54.0				AD	Drill rate. 2 min.
56.0	CL		S-10	P	55.0 - 57.0' Shelby tube push Recovered: 2.0'

DWR 885 (2) (Rev. 9-84)

State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES
DRILL HOLE LOG

SHEET 4 of 4

HOLE NO. SW2-2

PROJECT & FEATURE Sutter Bypass ImprovementsWeir No. 2

DEPTH (ELEV.)	LOG	FIELD CLASSIFICATION AND DESCRIPTION	SAMPLE NO.	MODE	REMARKS
56.0	CL	RECENT ALLUVIUM 0 to 61.5' 52.0 to 61.5' <u>Lean Clay, (CL):</u> cont.	S-10	P	55.0 - 57.0' Shelby push cont. Recovered: 2.0'
58.0		Lean Clay to Silty Clay; olive brown; very stiff to hard.	B-11	DR	57.0 - 58.5' SPT Drive: 6/9/9 N= 18 Recovered: 1.5'
		Silty Clay, 60% clay, 40% silt.		AD	
60.0	CL		B-12	DR	60.0 - 61.5' SPT Drive: 2/4/7 N= 11 Recovered: 1.5'
62.0 (-19')		Total Depth - 61.5'			Backfilled hole with bentonite-cement grout using a tremie pipe.

DWR 885 (2) (Rev. 9-84)

ATTACHMENT 4

Laboratory Soil Classification Data

Gradational and Plasticity Test Results

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

CLASSIFICATION TEST SUMMARY

DIVISION OF ENGINEERING
CIVIL ENGINEERING
CANALS AND LEVEES SECTION

PROJECT: SUTTER BYPASS FISH PASSAGE IMPROVEMENT PROJECT **FEATURE:** WEIR NO. 2

LAB. NO.	HOLE NO.	F.S. NO.	DEPTH (feet)	PERCENT FINER — MECHANICAL ANALYSIS — GRAVEL 3.0" 75 mm	1.5" 37.5 mm	3/4" 19 mm	3/8" 9.5 mm	4 4.75 mm	SAND 8 2.36 mm	16 1.18 mm	30 0.6 mm	50 0.3 mm	100 0.15 mm	HYDROMETER — SILT & CLAY 200 0.075 mm	5M 0.005 mm	2M 0.002 mm	1M 0.001 mm	ATTERBERG LIMITS L.L.	P.I.	SPEC. GRAV - #4	GROUP SYMBOL	CLASSIFICATION GROUP NAME
03-898	SW2 1	B1	7.0 - 8.5					100	99	99	98	95	89	79				34	10		ML	Silt with sand
03-900	"	B3	17.0 18.5						100	95	77	33	12	7					NP		SP SM	Poorly graded sand with silt
03 944A	"	S4	20.0 22.0																			
03-944B	"	"	"																			
03 944C	"	"	"																			
03-902	"	B5	26.0 - 27.5				100	99	99	98	92	72	60	56				28	8		CL	Sandy lean clay
03-904	"	B7	36.0 - 37.5							100	99	96	89	87				44	22		CL	Lean clay
03-906	"	B9	47.0 - 48.5		100	98	96	94	93	91	87	82	67	40				23	1		SM	Silty sand
03-919	SW2-2	B2	12.0 - 13.5						100	99	99	99	98	95				39	10		ML	Silt
03-920	"	B3	17.0 - 18.5							100	98	89	71	47				28	5		SM	Silty sand
03-955A	"	S4	20.0 - 22.0																			
03-955B	"	"	"																			
03 955C	"	"	"																			
03 921	"	B4	22.0 - 23.5									100	99	96				56	38		CH	Fat clay
03-922	"	B5	27.0 28.5								100	99	96	91				34	9		ML	Silt

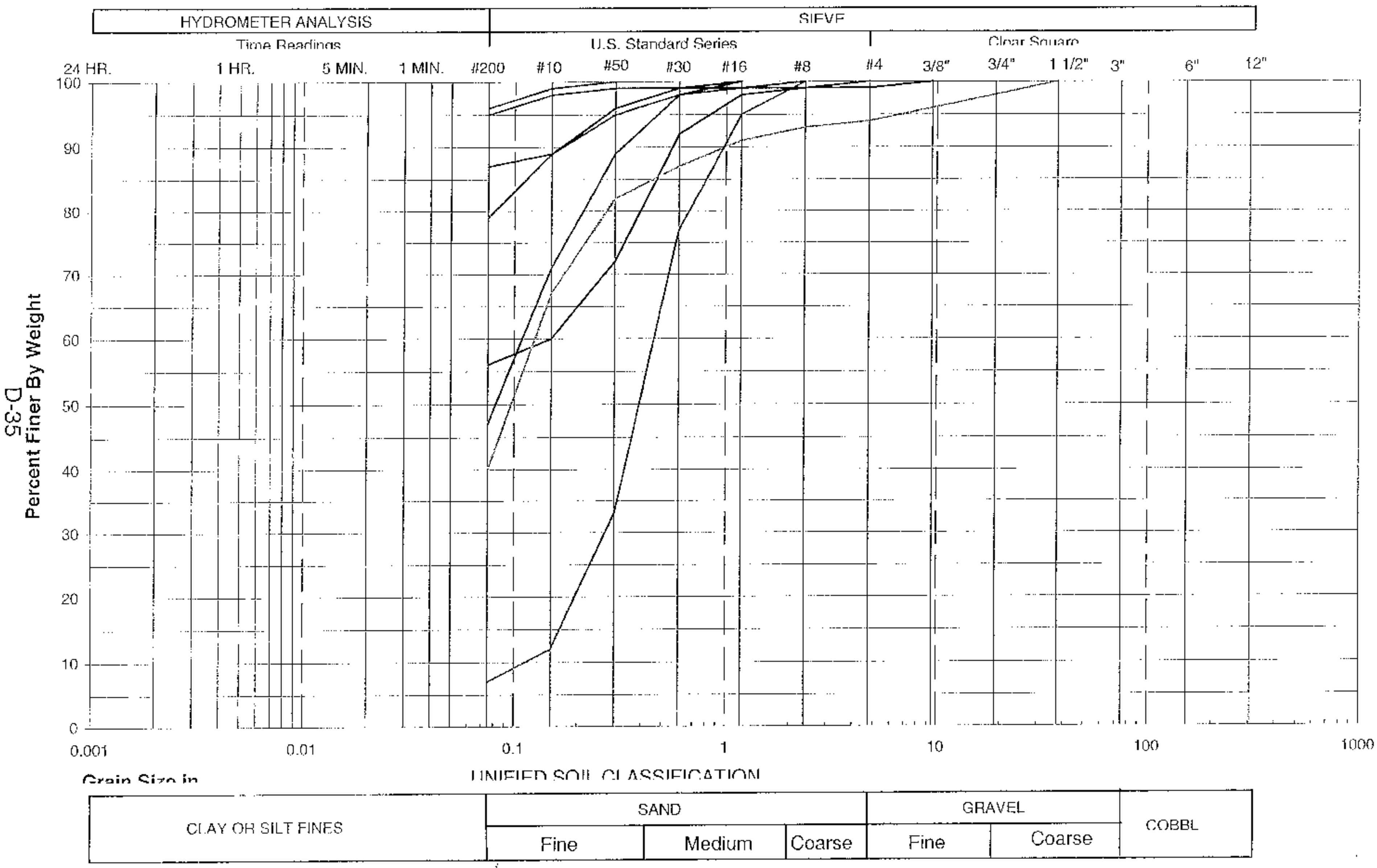
D-34

DATE: 9/15/2003
INITIAL: rgj
REQUEST NO.: 03-28

REMARKS:

IM - INSUFFICIENT MATERIAL
NP - NON-PLASTIC
NG - NO GOOD

Particle Size Analysis Graph



DELTA ENVIRONMENTAL STUDY
REQUEST NO. 02-37
NOVEMBER SAMPLES

Sample SW2-1 Consolidated Undrained Triaxial Shear Strength Testing (CUE) Results

Sutter Bypass Weir #2

SAMPLE SW2-1, S-3; 15-17 and 20-22 BGS

ASTM 4767: TRIAXIAL COMPRESSION TEST RESULTS

CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEARSUREMENTS

Request No. - 2003-28 Test Date - 12/1/2003

03-943C

Effective Confining Pressure (psi) = 11.4
Dry Density (pcf) = 95.3
PI =
% Fines =
Water Content (%) = 23.6

FAILURE CRITERIA SELECTION	
Effective	
Dev. Stress @ Failure (psi)	54.7
Excess Pore Pressure @ Failure (psi)	-4.2
Total	
Dev. Stress @ Failure (psi)	86.8

Axial Strain ε (%)	Excess Pore Pressure Δu (psi)	Effective Confining Stress σ_3' (psi)	Stress Ratio σ_1'/σ_3'	Deviator Stress $(\sigma_1-\sigma_3)$ (psi)
0.0	0.00	11.38	1.00	0.01
0.1	0.03	11.35	1.06	0.63
0.2	0.06	11.32	1.06	0.65
0.5	1.47	9.90	1.58	5.76
1.0	4.05	7.32	3.03	14.87
2	2.73	8.65	4.15	27.24
3	-0.71	12.10	4.45	41.89
3.86	-4.18	15.56	4.52	54.69
4	-4.74	16.12	4.51	56.63
5	-8.91	20.29	4.49	70.74
6	-12.70	24.08	4.42	82.43
6.49	-14.22	25.62	4.39	86.79
7	-15.65	27.04	4.34	90.32
8	-18.21	29.60	4.25	96.30
9	-20.41	31.79	4.18	101.10
10	-22.16	33.55	4.10	103.97
11	-23.77	35.15	3.96	104.08
12	-23.99	35.37	3.82	99.86
13	-23.33	34.71	3.77	96.16
14	-22.03	33.42	3.73	91.36
15	-20.72	32.10	3.75	88.25
16	-19.72	31.11	3.77	86.01
17	-18.93	30.30	3.78	84.35
18	-18.20	29.59	3.74	80.98
19	-17.42	28.80	3.68	77.04
20	-16.65	28.03	3.67	74.88

03-944B

Effective Confining Pressure (psi) = 17.8
Dry Density (pcf) = 93.18
PI =
% Fines =
Water Content (%) = 11.1

FAILURE CRITERIA SELECTION	
Effective	
Dev. Stress @ Failure (psi)	55.8
Excess Pore Pressure @ Failure (psi)	0.4
Total	
Dev. Stress @ Failure (psi)	97.0

Axial Strain ε (%)	Excess Pore Pressure Δu (psi)	Effective Confining Stress σ_3' (psi)	Stress Ratio σ_1'/σ_3'	Deviator Stress $(\sigma_1-\sigma_3)$ (psi)
0.00	0.00	17.79	1.00	0.07
0.10	0.07	17.73	1.02	0.38
0.50	0.99	16.79	1.13	2.24
1.00	7.63	10.15	2.55	15.66
2.00	8.59	9.20	3.62	24.11
3.00	6.62	11.17	4.00	33.56
4.00	3.75	14.05	4.16	44.32
5.00	0.44	17.36	4.21	55.76
6.00	-3.03	20.82	4.22	67.13
7.00	-6.40	24.20	4.19	77.26
8.00	-9.41	27.20	4.15	85.60
9.00	-12.17	29.97	4.08	92.52
9.78	-14.20	31.99	4.03	96.96
10.00	-14.74	32.53	4.01	97.93
11.00	-16.89	34.69	3.94	101.92
12.00	-18.79	36.59	3.87	104.96
13.00	-20.46	38.26	3.79	106.86
14.00	-21.90	39.69	3.73	108.44
15.00	-23.09	40.90	3.64	108.00
16.00	-23.60	41.40	3.53	104.51
17.00	-23.13	40.92	3.48	101.38
18.00	-21.83	39.62	3.47	97.97
19.00	-20.41	38.20	3.52	98.29
20.00	-19.48	37.28	3.54	94.79

03-944C

Effective Confining Pressure (psi) = 28.5
Dry Density (pcf) = 97.3
PI =
% Fines =
Water Content (%) = 22.2

FAILURE CRITERIA SELECTION	
Effective	
Dev. Stress @ Failure (psi)	60.0
Excess Pore Pressure @ Failure (psi)	8.6
Total	
Dev. Stress @ Failure (psi)	99.1

Axial Strain ε (%)	Excess Pore Pressure Δu (psi)	Effective Confining Stress σ_3' (psi)	Stress Ratio σ_1'/σ_3'	Deviator Stress $(\sigma_1-\sigma_3)$ (psi)
0.00	0.00	28.48	1.00	0.04
0.10	0.10	28.38	1.01	0.36
0.15	0.18	28.29	1.02	0.48
0.45	2.56	25.92	1.27	6.98
1.04	12.64	15.83	2.54	24.36
2.02	14.68	13.80	3.43	33.47
3.02	13.30	15.18	3.78	42.17
4.02	11.08	17.40	3.94	51.13
5.00	8.56	19.90	4.01	59.96
6.01	5.70	22.77	4.05	69.48
7.03	2.78	25.70	4.06	78.55
8.03	-0.10	28.57	4.05	86.87
9.05	-2.66	31.12	4.02	93.84
10.02	-4.83	33.30	3.98	99.10
11.00	-6.81	35.29	3.95	104.02
12.03	-8.70	37.18	3.91	108.14
13.04	-10.33	38.80	3.87	111.30
14.01	-11.78	40.25	3.81	113.21
15.04	-13.11	41.57	3.68	111.43
16.04	-12.89	41.36	3.56	105.95
17.00	-11.66	40.13	3.54	101.98
18.01	-10.30	38.77	3.57	99.78
19.04	-9.12	37.59	3.59	97.41
20.00	-8.08	36.55	3.62	95.68

Sample	Cells highlighted with red text and light yellow shade require input data
Sample	Cells highlighted light green - data used in calculating mohrs circles for effective (drained) stress
Sample	Cells highlighted gray - data used in calculating mohrs circles for total (undrained) stress

SAMPLE NUMBER	CONFINING PRESSURE	FAILURE CRITERIA USED	DEVIATOR STRESS	PORE PRESSURE AT FAILURE	$\sigma_{3f} = \sigma_{3c} - \Delta u$
03-943C	11.38	Max stress ratio @ 3.86%	54.7	-4.2	15.579

03-943C ; Effective Conf.Pressure = 11.38 ksc

MOHR CIRCLE RADIUS	MOHR CIRCLE MIDPOINT	VALUES FOR PLOTTING X NORMAL	Y SHEAR	CIRCLE COORD CALCULATIONS c	m
27.35	42.929	15.579	0.00	54.700	27.350
		15.716	2.73	54.427	24.618
		16.172	5.66	53.515	21.688
		16.855	8.26	52.147	19.092
		17.767	10.72	50.324	16.631
		19.135	13.48	47.589	13.865
		20.502	15.65	44.854	11.696
		21.870	17.45	42.119	9.899
		23.237	18.98	39.384	8.370
		24.605	20.30	36.649	7.046
		25.972	21.46	33.914	5.891
		27.340	22.47	31.179	4.878
		28.707	23.36	28.444	3.989
		30.075	24.14	25.709	3.209
		31.442	24.82	22.974	2.529
		32.810	25.41	20.239	1.941
		34.418	25.99	17.021	1.358
		36.242	26.52	13.375	0.830
		38.065	26.91	9.728	0.436
		40.344	27.23	5.170	0.122
		42.929	27.35	0.000	0.000
		45.514	27.23	5.170	0.122
		47.793	26.91	9.728	0.436
		49.616	26.52	13.375	0.830
		51.440	25.99	17.021	1.358
		53.049	25.41	20.239	1.941
		54.416	24.82	22.974	2.529
		55.784	24.14	25.709	3.209
		57.151	23.36	28.444	3.989
		58.519	22.47	31.179	4.878
		59.886	21.46	33.914	5.891
		61.254	20.30	36.649	7.046
		62.621	18.98	39.384	8.370
		63.989	17.45	42.119	9.899
		65.356	15.65	44.854	11.696
		66.724	13.48	47.589	13.865
		68.091	10.72	50.324	16.631
		69.003	8.26	52.147	19.092
		69.686	5.66	53.515	21.688
		70.142	2.73	54.427	24.618
		70.279	0.00	54.700	27.350

SAMPLE NUMBER	CONFINING PRESSURE	FAILURE CRITERIA USED	DEVIATOR STRESS	PORE PRESSURE AT FAILURE	$\sigma_{3f} = \sigma_{3c} - \Delta u$
03-944B	17.79	Max stress ratio @ 5%	55.8	0.44	17.35

03-944B ; Effective Conf.Pressure = 17.79 ksc

MOHR CIRCLE RADIUS	MOHR CIRCLE MIDPOINT	VALUES FOR PLOTTING X NORMAL	Y SHEAR	CIRCLE COORD CALCULATIONS c	m
27.9	45.69	17.35	0.00	55.800	27.900
		17.490	2.79	55.521	25.113
		17.955	5.78	54.591	22.124
		18.652	8.42	53.196	19.476
		19.582	10.93	51.336	16.965
		20.977	13.76	48.546	14.144
		22.372	15.97	45.756	11.931
		23.767	17.80	42.966	10.099
		25.162	19.36	40.176	8.538
		26.557	20.71	37.386	7.188
		27.952	21.89	34.596	6.010
		29.347	22.92	31.806	4.976
		30.742	23.83	29.016	4.069
		32.137	24.63	26.226	3.274
		33.532	25.32	23.436	2.580
		34.927	25.92	20.646	1.980
		36.568	26.51	17.364	1.385
		38.428	27.05	13.644	0.847
		40.288	27.46	9.924	0.445
		42.613	27.78	5.274	0.125
		45.250	27.90	0.000	0.000
		47.887	27.78	5.274	0.125
		50.212	27.46	9.924	0.445
		52.072	27.05	13.644	0.847
		53.932	26.51	17.364	1.385
		55.573	25.92	20.646	1.980
		56.968	25.32	23.436	2.580
		58.363	24.63	26.226	3.274
		59.758	23.83	29.016	4.069
		61.153	22.92	31.806	4.976
		62.548	21.89	34.596	6.010
		63.943	20.71	37.386	7.188
		65.338	19.36	40.176	8.538
		66.733	17.80	42.966	10.099
		68.128	15.97	45.756	11.931
		69.523	13.76	48.546	14.144
		70.918	10.93	51.336	16.965
		71.848	8.42	53.196	19.476
		72.546	5.78	54.591	22.124
		73.011	2.79	55.521	25.113
		73.150	0.00	55.800	27.900

SAMPLE NUMBER	CONFINING PRESSURE	FAILURE CRITERIA USED	DEVIATOR STRESS	PORE PRESSURE AT FAILURE	$\sigma_{3f} = \sigma_{3c} - \Delta u$
03-944C	28.46	Max stress ratio @ 5%	60	8.6	19.859

03-944C ; Effective Conf.Pressure = 28.46 ksc

MOHR CIRCLE RADIUS	MOHR CIRCLE MIDPOINT	VALUES FOR PLOTTING X NORMAL	Y SHEAR	CIRCLE COORD CALCULATIONS c	m
30	49.859	19.859	0.00	60.000	30.000
		20.009	3.00	59.700	27.004
		20.509	6.21	58.700	23.789
		21.259	9.06	57.200	20.942
		22.259	11.76	55.200	18.242
		23.759	14.79	52.200	15.208
		25.259	17.17	49.200	12.829
		26.759	19.14	46.200	10.859
		28.259	20.82	43.200	9.181
		29.759	22.27	40.200	7.729
		31.259	23.54	37.200	6.462
		32.759	24.65	34.200	5.351
		34.259	25.62	31.200	4.375
		35.759	26.48	28.200	3.520
		37.259	27.23	25.200	2.774
		38.759	27.87	22.200	2.129
		40.524	28.51	18.671	1.489
		42.524	29.09	14.671	0.911
		44.524	29.52	10.671	0.478
		47.024	29.87	5.671	0.134
		49.859	30.00	0.000	0.000
		52.694	29.87	5.671	0.134
		55.194	29.52	10.671	0.478
		57.194	29.09	14.671	0.911
		59.194	28.51	18.671	1.489
		60.959	27.87	22.200	2.129
		62.459	27.23	25.200	2.774
		63.959	26.48	28.200	3.520
		65.459	25.62	31.200	4.375
		66.959	24.65	34.200	5.351
		68.459	23.54	37.200	6.462
		69.959	22.27	40.200	7.729
		71.459	20.82	43.200	9.181
		72.959	19.14	46.200	10.859
		74.459	17.17	49.200	12.829
		75.959	14.79	52.200	15.208
		77.459	11.76	55.200	18.242
		78.459	9.06	57.200	20.942
		79.209	6.21	58.700	23.789
		79.709	3.00	59.700	27.004
		79.859	0.00	60.000	30.000

Data for Shear Envelope Plot:

φ' (deg) =	28	phi' = 28 degrees
φ' (rad) =	0.4887	
C (psf) =	1000	c' = 6.9 psi = 1000 psf
C (psi) =	6.9444	

σ (psi)	τ (psi)
0	6.9444
10	12.2615
20	17.5786
30	22.8957
60	38.8470

SAMPLE NUMBER	FAILURE CRITERIA USED	$\sigma_{3i} = \sigma_{3c}$ CONFINING PRESSURE	DEVIATOR STRESS	FAILURE CRITERIA TO FOLLOW
03-943C	Max Dev. @ 6.49%	11.38	86.8	10% OR MAX. DEV.

MOHR CIRCLE RADIUS	MOHR CIRCLE MIDPOINT	VALUES FOR PLOTTING X NORMAL	Y SHEAR	CIRLCE COORD CALCULATIONS c	m
43.4	54.779	11.379	0.00	86.800	43.400
		11.596	4.33	86.366	39.065
		12.319	8.99	84.919	34.415
		13.404	13.10	82.749	30.297
		14.851	17.01	79.856	26.391
		17.021	21.40	75.516	22.002
		19.191	24.84	71.176	18.559
		21.361	27.69	66.836	15.709
		23.531	30.12	62.496	13.282
		25.701	32.22	58.156	11.182
		27.871	34.05	53.816	9.348
		30.041	35.66	49.476	7.741
		32.211	37.07	45.136	6.329
		34.381	38.31	40.796	5.092
		36.551	39.39	36.456	4.013
		38.721	40.32	32.116	3.080
		41.274	41.25	27.010	2.155
		44.167	42.08	21.223	1.317
		47.061	42.71	15.437	0.692
		50.677	43.21	8.203	0.194
		54.779	43.40	0.000	0.000
		58.881	43.21	8.203	0.194
		62.497	42.71	15.437	0.692
		65.391	42.08	21.223	1.317
		68.284	41.25	27.010	2.155
		70.837	40.32	32.116	3.080
		73.007	39.39	36.456	4.013
		75.177	38.31	40.796	5.092
		77.347	37.07	45.136	6.329
		79.517	35.66	49.476	7.741
		81.687	34.05	53.816	9.348
		83.857	32.22	58.156	11.182
		86.027	30.12	62.496	13.282
		88.197	27.69	66.836	15.709
		90.367	24.84	71.176	18.559
		92.537	21.40	75.516	22.002
		94.707	17.01	79.856	26.391
		96.154	13.10	82.749	30.297
		97.239	8.99	84.919	34.415
		97.962	4.33	86.366	39.065
		98.179	0.00	86.800	43.400

SAMPLE NUMBER	FAILURE CRITERIA USED	$\sigma_{3i} = \sigma_{3c}$ CONFINING PRESSURE	DEVIATOR STRESS	FAILURE CRITERIA TO FOLLOW
03-944B	Max Dev. @ 9.78%	17.79	97	10% OR MAX. DEV.

MOHR CIRCLE RADIUS	MOHR CIRCLE MIDPOINT	VALUES FOR PLOTTING X NORMAL	Y SHEAR	CIRLCE COORD CALCULATIONS c	m
48.5	66.29	17.79	0.00	97.000	48.500
		18.033	4.84	96.515	43.656
		18.841	10.04	94.898	38.459
		20.053	14.64	92.473	33.857
		21.670	19.01	89.240	29.492
		24.095	23.91	84.390	24.587
		26.520	27.76	79.540	20.740
		28.945	30.95	74.690	17.555
		31.370	33.66	69.840	14.842
		33.795	36.00	64.990	12.495
		36.220	38.05	60.140	10.447
		38.645	39.85	55.290	8.650
		41.070	41.43	50.440	7.073
		43.495	42.81	45.590	5.691
		45.920	44.01	40.740	4.485
		48.345	45.06	35.890	3.442
		51.198	46.09	30.184	2.408
		54.431	47.03	23.717	1.472
		57.665	47.73	17.251	0.773
		61.706	48.28	9.167	0.217
		66.290	48.50	0.000	0.000
		70.874	48.28	9.167	0.217
		74.915	47.73	17.251	0.773
		78.149	47.03	23.717	1.472
		81.382	46.09	30.184	2.408
		84.235	45.06	35.890	3.442
		86.660	44.01	40.740	4.485
		89.085	42.81	45.590	5.691
		91.510	41.43	50.440	7.073
		93.935	39.85	55.290	8.650
		96.360	38.05	60.140	10.447
		98.785	36.00	64.990	12.495
		101.210	33.66	69.840	14.842
		103.635	30.95	74.690	17.555
		106.060	27.76	79.540	20.740
		108.485	23.91	84.390	24.587
		110.910	19.01	89.240	29.492
		112.527	14.64	92.473	33.857
		113.739	10.04	94.898	38.459
		114.548	4.84	96.515	43.656
		114.790	0.00	97.000	48.500

SAMPLE NUMBER	FAILURE CRITERIA USED	$\sigma_{3i} = \sigma_{3c}$ CONFINING PRESSURE	DEVIATOR STRESS	FAILURE CRITERIA TO FOLLOW
03-944C	Max Dev. @ 10%	28.46	99.1	10% OR MAX. DEV.

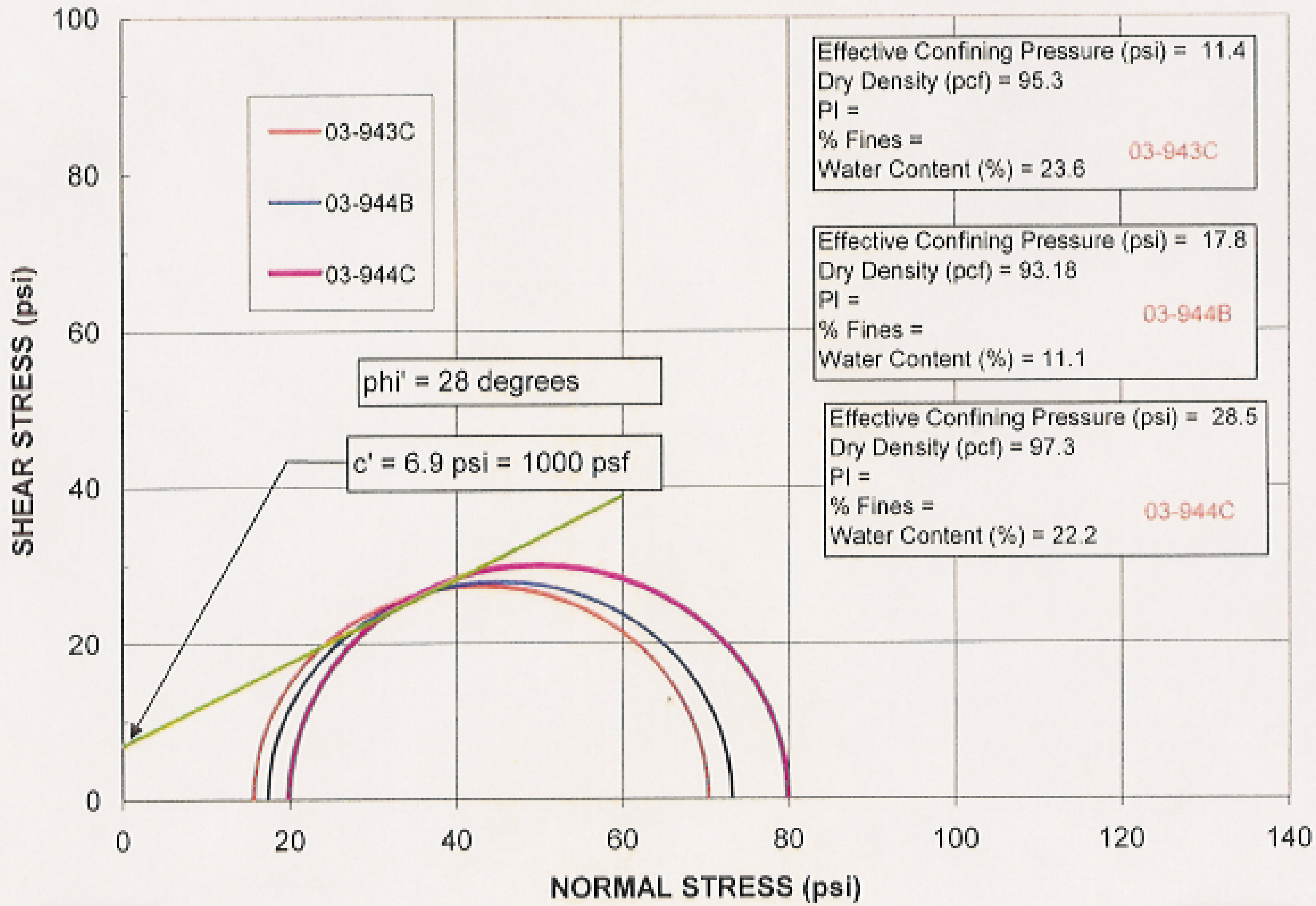
MOHR CIRCLE RADIUS	MOHR CIRCLE MIDPOINT	VALUES FOR PLOTTING X NORMAL	Y SHEAR	CIRLCE COORD CALCULATIONS c	m
49.55	78.009	28.459	0.00	99.100	49.550
		28.707	4.95	98.605	44.601
		29.533	10.26	96.953	39.291
		30.771	14.96	94.475	34.590
		32.423	19.42	91.172	30.130
		34.901	24.43	86.217	25.119
		37.378	28.36	81.262	21.189
		39.856	31.62	76.307	17.935
		42.333	34.39	71.352	15.164
		44.811	36.78	66.397	12.766
		47.288	38.88	61.442	10.673
		49.766	40.71	56.487	8.838
		52.243	42.32	51.532	7.226
		54.721	43.74	46.577	5.814
		57.198	44.97	41.622	4.582
		59.676	46.03	36.667	3.516
		62.590	47.09	30.838	2.460
		65.894	48.05	24.231	1.504
		69.197	48.76	17.624	0.790
		73.326	49.33	9.366	0.222
		78.009	49.55	0.000	0.000
		82.692	49.33	9.366	0.222
		86.821	48.76	17.624	0.790
		90.124	48.05	24.231	1.504
		93.428	47.09	30.838	2.460
		96.343	46.03	36.667	3.516
		98.820	44.97	41.622	4.582
		101.298	43.74	46.577	5.814
		103.775	42.32	51.532	7.226
		106.253	40.71	56.487	8.838
		108.730	38.88	61.442	10.673
		111.208	36.78	66.397	12.766
		113.685	34.39	71.352	15.164
		116.163	31.62	76.307	17.935
		118.640	28.36	81.262	21.189
		121.118	24.43	86.217	25.119
		123.595	19.42	91.172	30.130
		125.247	14.96	94.475	34.590
		126.485	10.26	96.953	39.291
		127.311	4.95	98.605	44.601
		127.559	0.00	99.100	49.550

Data for Shear Envelope Plot:

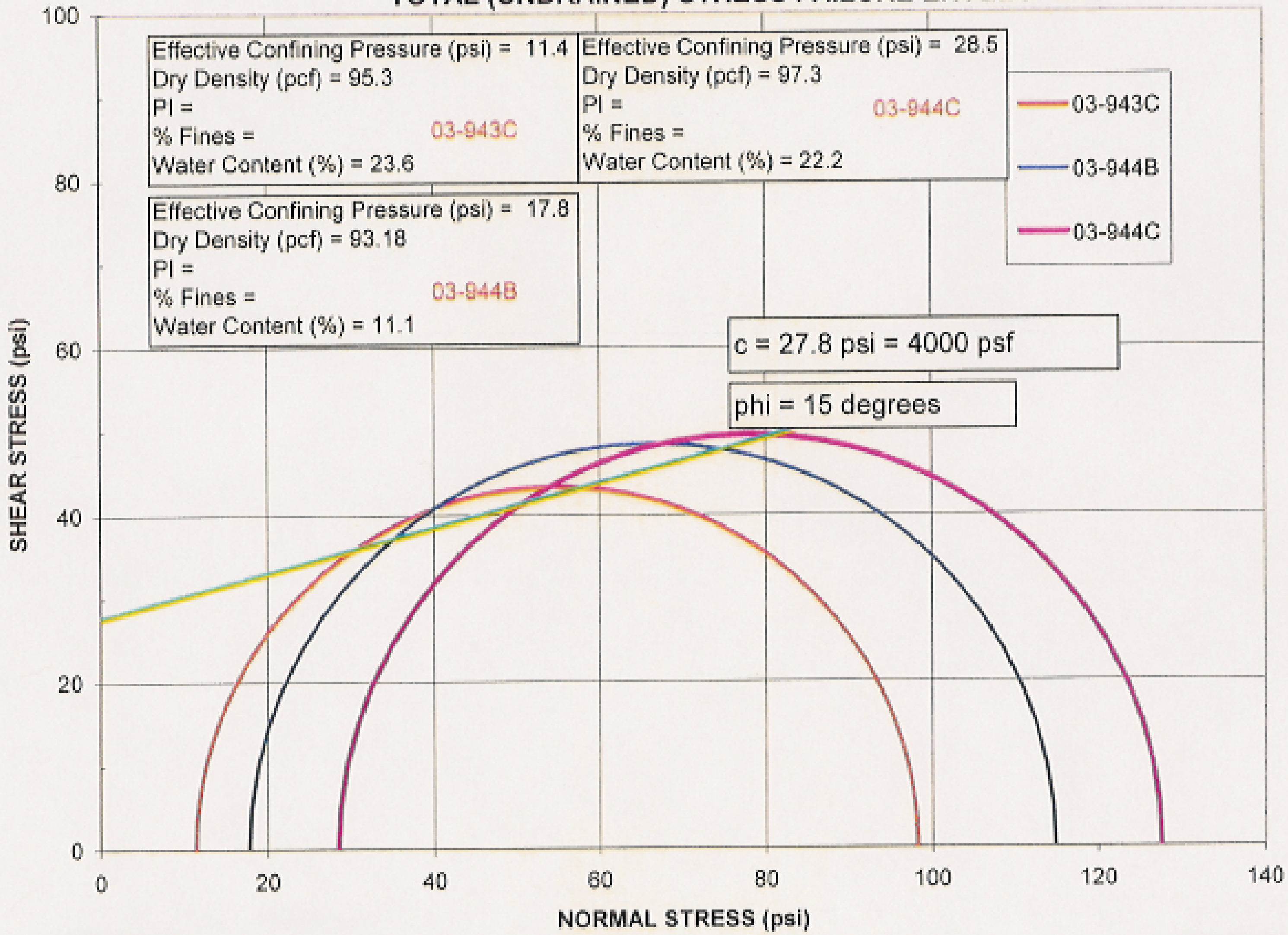
ϕ (deg) = 15 phi = 15 degrees
ϕ (rad) = 0.2618
C (psf) = 4000 c = 27.8 psi = 4000 psf
C (ksc) = 27.7778

0	27.7778
10	30.4573
20	33.1368
30	35.8163
100	54.5727

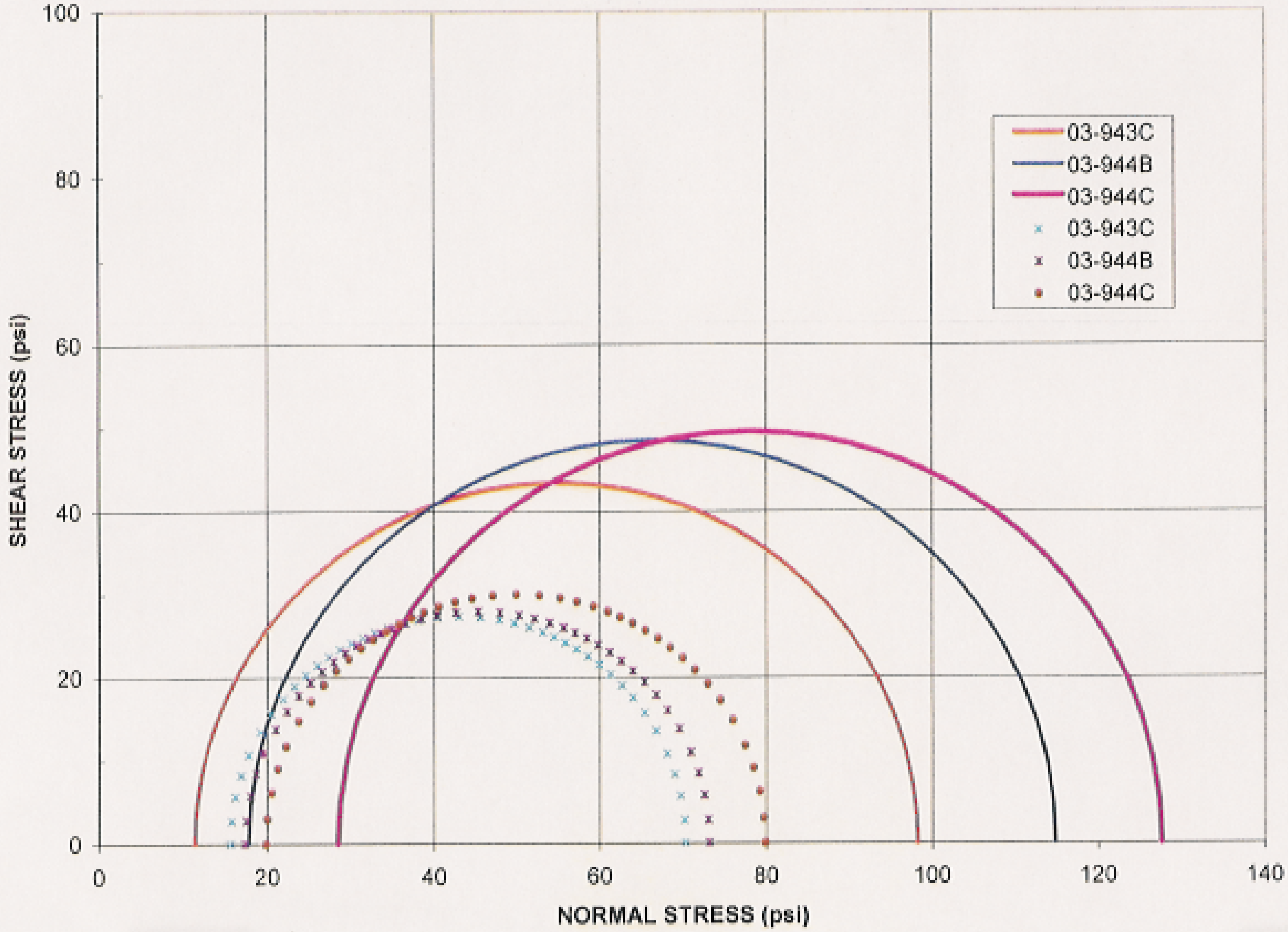
SAMPLE SW2-1, S-3; 15-17 and 20-22 BGS
EFFECTIVE (DRAINED) STRESS FAILURE ENVELOPE



SAMPLE SW2-1, S-3; 15-17 and 20-22 BGS
TOTAL (UNDRAINED) STRESS FAILURE ENVELOPES



TOTAL & EFFECTIVE STRESS FAILURE ENVELOPES



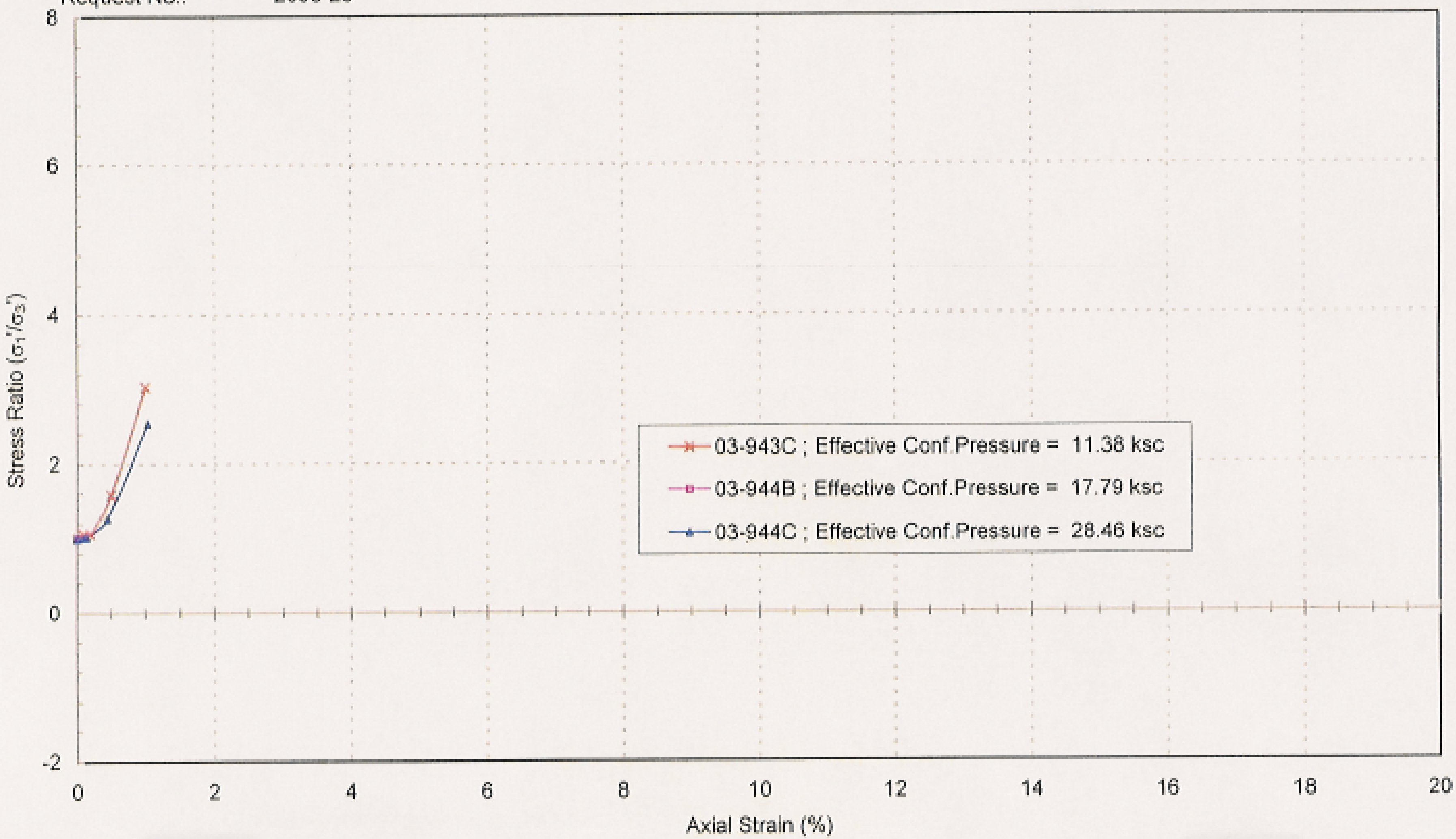
TRIAXIAL COMPRESSION

ASTM 4767 : Consolidated, Undrained Compressive Strength of Cohesive Soils

Stress Ratio versus Axial Strain

Request No.: 2003-28

Test Date: 12/1/20

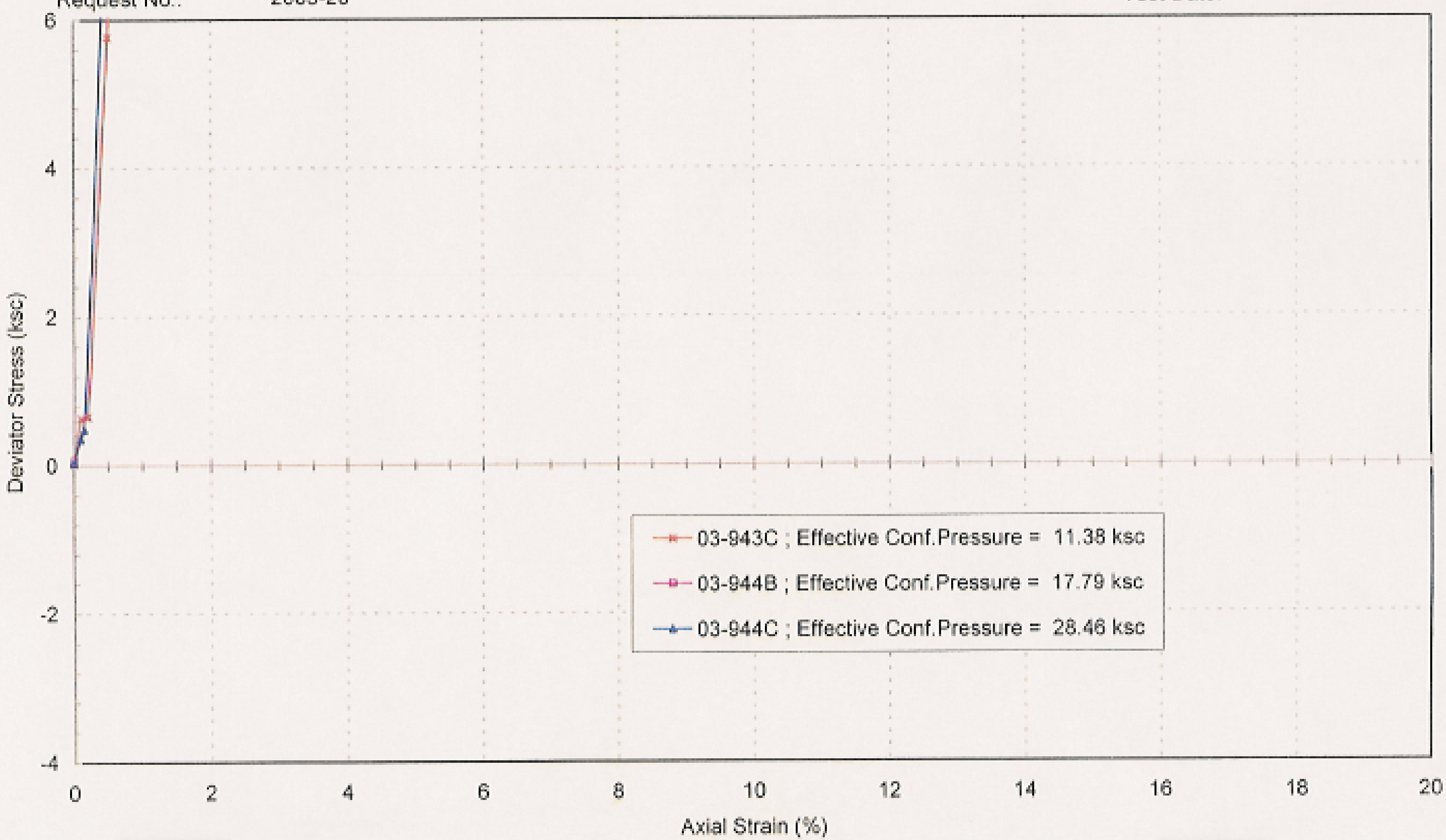


TRIAXIAL COMPRESSION

ASTM 4767 : Consolidated, Undrained Compressive Strength of Cohesive Soils

Deviator Stress versus Axial Strain

Request No.: 2003-28 Test Date: 12/1/20



D-44

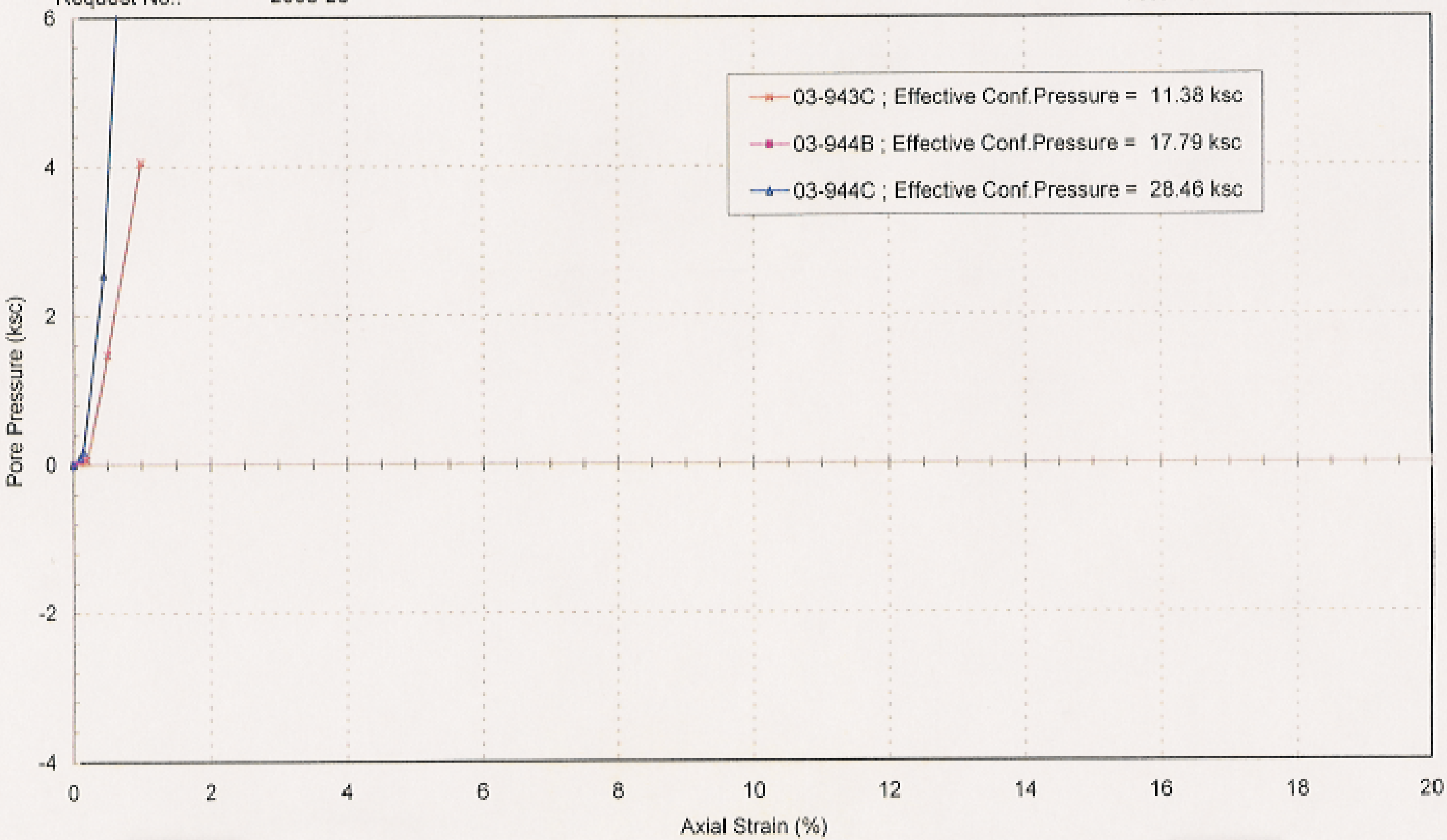
TRIAXIAL COMPRESSION

ASTM 4767 : Consolidated, Undrained Compressive Strength of Cohesive Soils

Pore Pressure versus Axial Strain

Request No.: 2003-28

Test Date: 12/1/20

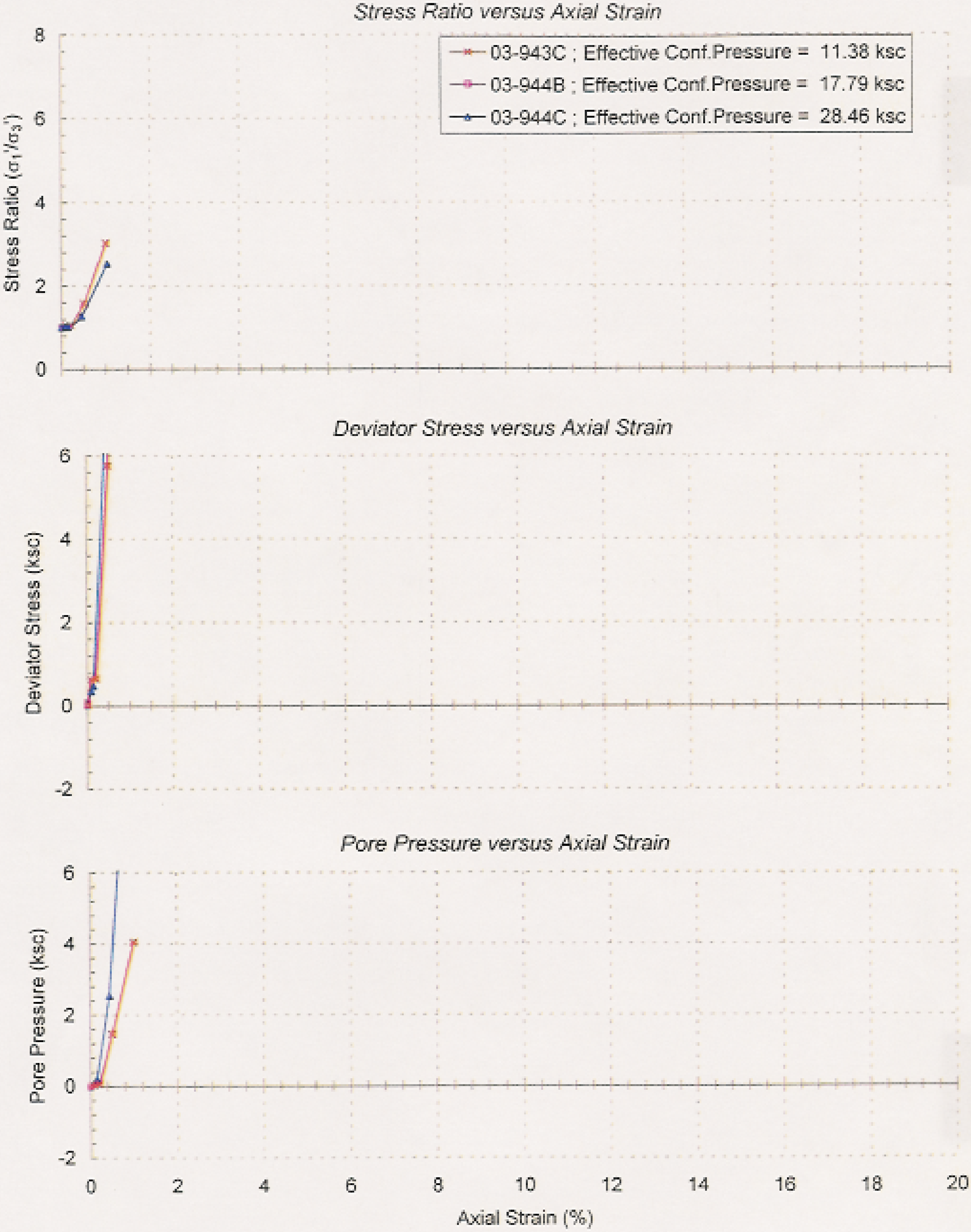


SAMPLE DA-11, S-1, 5-7.5' BGS

TRIAXIAL COMPRESSION

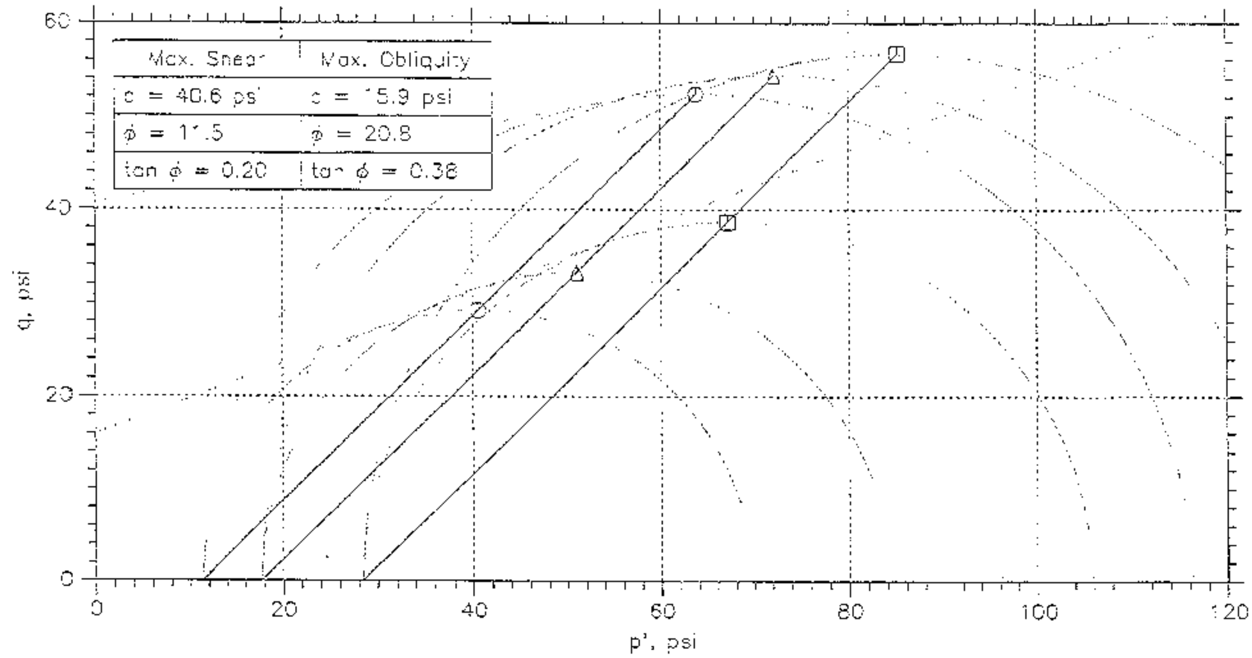
ASTM 4767: Consolidated, Undrained Compressive Strength

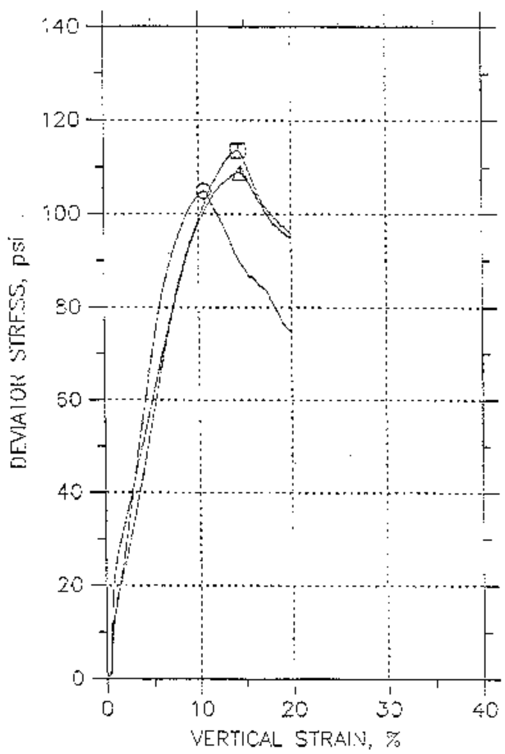
Request No.: 2003-23 Test Date: 09\9\03



SW2-1 CUE Undrained Test Results Modified with Pore Pressure Measurements

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





		⊙	△	⊡	
Symbol		⊙	△	⊡	
Sample No.		03-943	03-944	03-944	
Test No.		C	B	C	
Depth		15-17	20-22	20-22	
Initial	Diameter, in	2.882	2.883	2.888	
	Height, in	6.408	6.403	6.492	
	Water Content, %	23.6	11.1	22.2	
	Dry Density, pcf	95.25	93.18	97.25	
	Saturation, %	82.8	36.2	78.9	
	Void Ratio	0.77	0.842	0.778	
Before Shear	Water Content, %	24.5	12.9	22.9	
	Dry Density, pcf	101.5	126.8	105.8	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.661	0.353	0.634	
	Back Press., psi	40	49.99	41.99	
Ver. Eff. Cons. Stress, psi		11.38	17.79	28.47	
Shear Strength, psi		52.4	54.39	56.7	
Strain at Failure, %		10.6	14.6	14.4	
Strain Rate, %/min		0.05	0.05	0.05	
B-Value		0.95	0.95	0.95	
Estimated Specific Gravity		2.7	2.75	2.77	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	

WATER RESOURCES

Project: Sutter Bypass Weir #2	
Location: Bryte	
Project No.: 03-28	
Boring No.: SW2-1, S-3	
Sample Type: Shelby	
Description: Silty sand	
Remarks:	

Phase calculations based on start of test.

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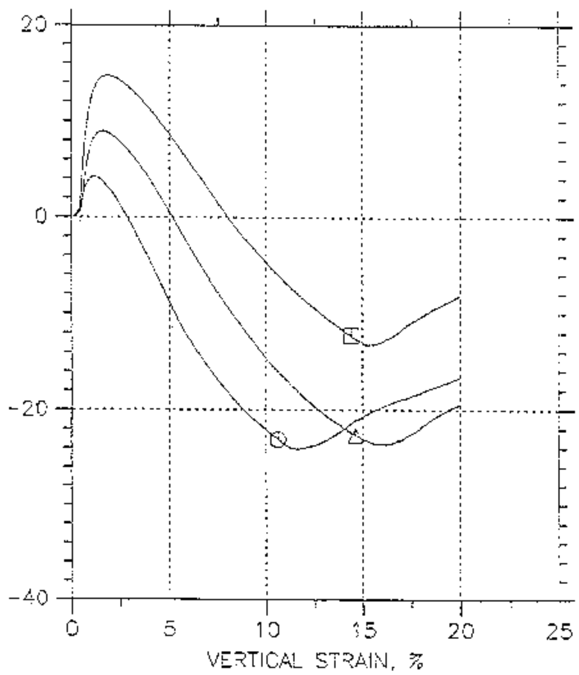
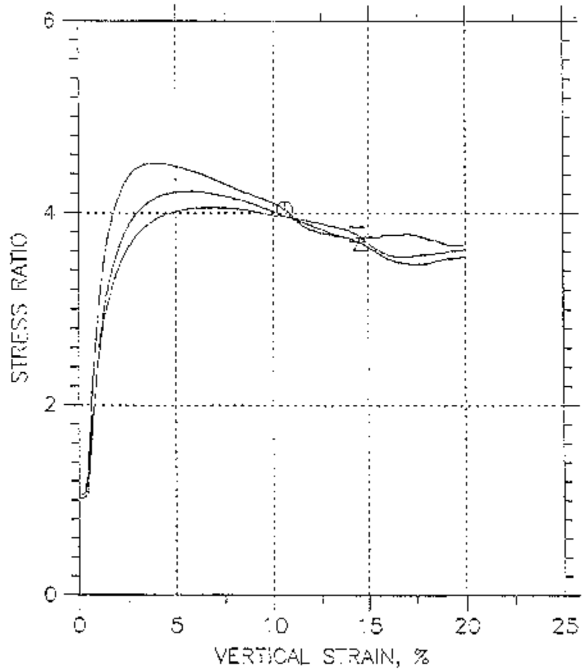
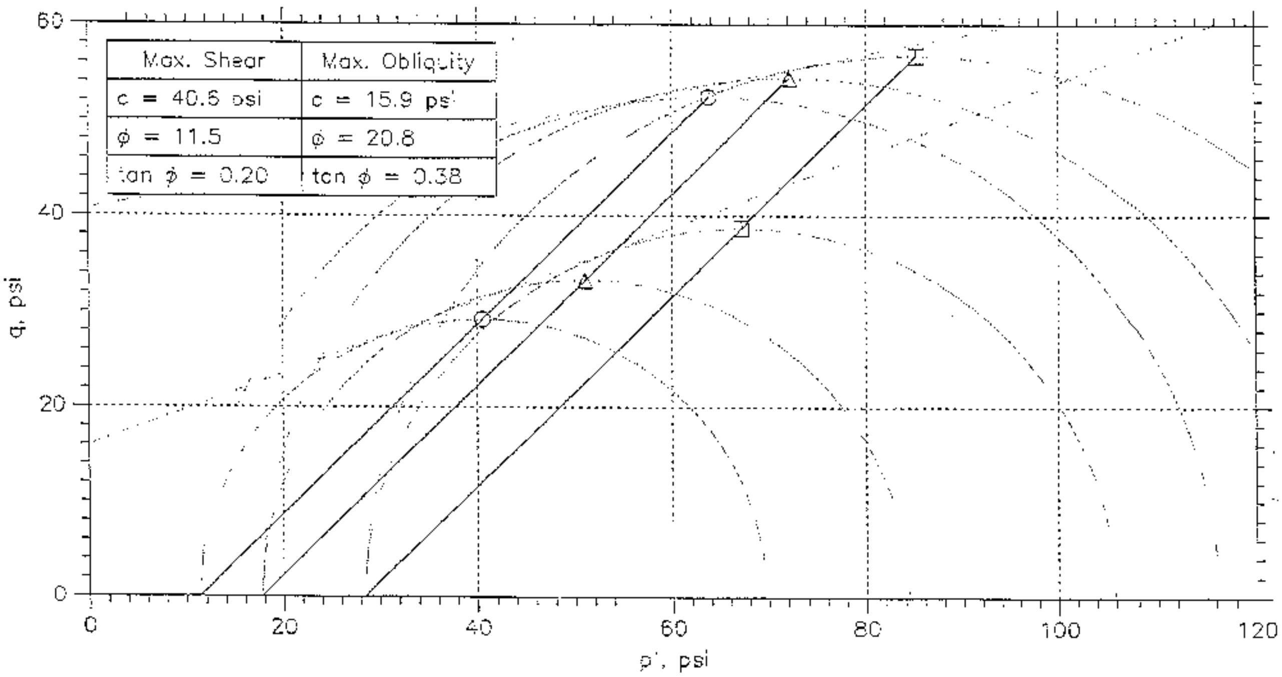
* Saturation is set to 100% for phase calculations.

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







Max. Shear	Max. Obliquity
c = 40.6 psi	c = 15.9 psi
ϕ = 11.5	ϕ = 20.8
tan ϕ = 0.20	tan ϕ = 0.38

	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	03-943	C	15-17	DN	12/5/2003	SF		03-943C.dat
△	03-944	B	20-22	DN	12/3/2003	SF		03-944B.dat
⊐	03-944	C	20-22	DN	12/1/2003	SF		03-944C.dat

Project: Sutter Bypass Weir #2	Location: Bryte	Project No.: 03-28
Boring No.: SW2-1, S-3	Sample Type: Shelby	
Description: Silty sand		
Remarks:		

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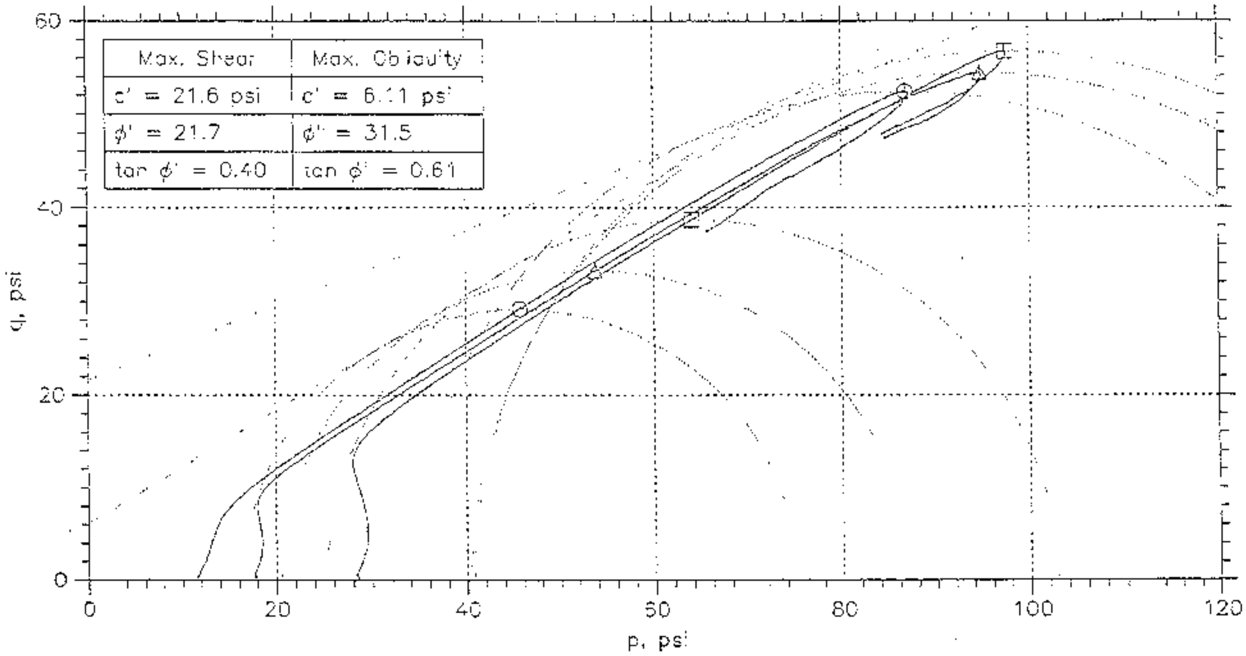
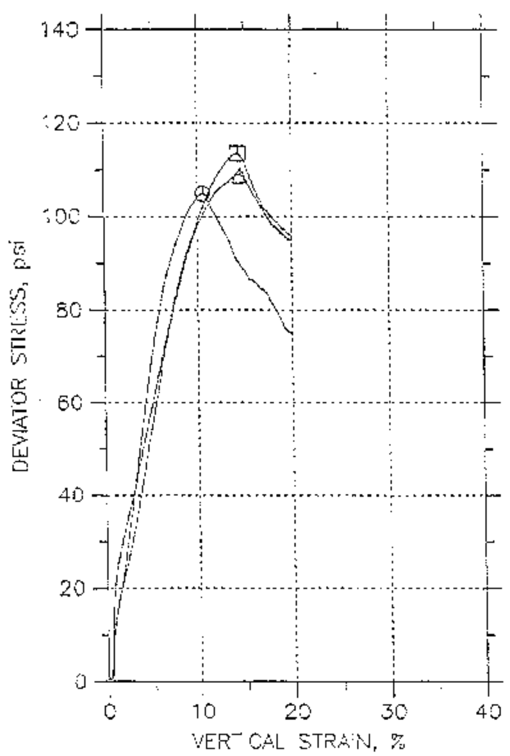
SW2-1 CUE Drained Test Results Modified with Pore Pressure Measurements

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





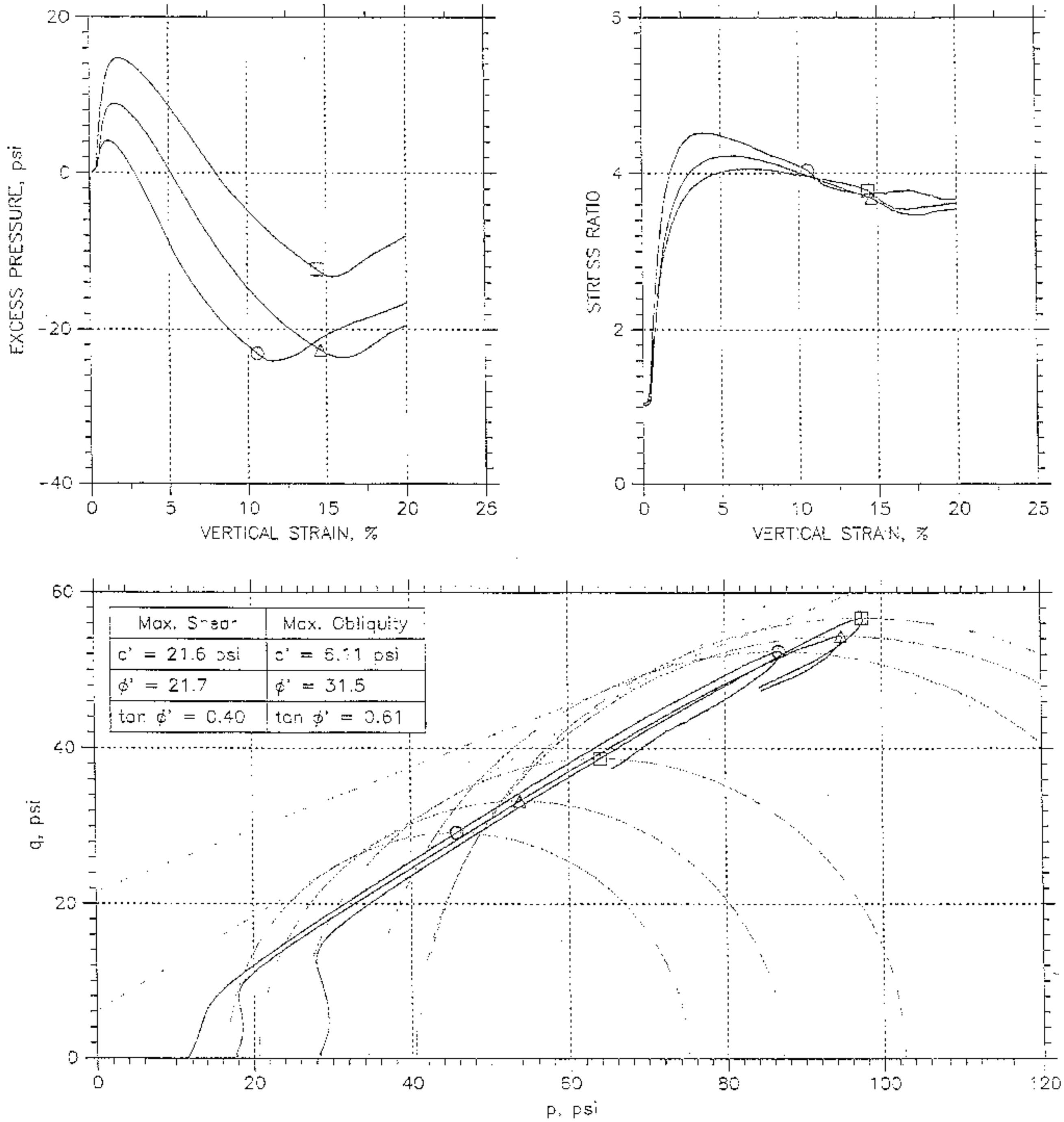
Symbol		○	△	□	
Sample No.		03-943	03-944	03-944	
Test No.		C	B	C	
Depth		15-17	20-22	20-22	
Initial	Diameter, in	2.882	2.883	2.888	
	Height, in	6.408	6.403	6.492	
	Water Content, %	23.6	11.1	22.2	
	Dry Density, pcf	95.25	93.18	97.25	
	Saturation, %	82.8	36.2	78.9	
	Void Ratio	0.77	0.842	0.778	
Before Shear	Water Content, %	24.5	12.9	22.9	
	Dry Density, pcf	101.5	126.8	105.8	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.661	0.353	0.634	
	Back Press., psi	40	49.99	41.99	
Ver. Eff. Cons. Stress, psi		11.38	17.79	28.47	
Shear Strength, psi		52.4	54.39	56.7	
Strain at Failure, %		10.6	14.6	14.4	
Strain Rate, %/min		0.05	0.05	0.05	
B-Value		0.95	0.95	0.95	
Estimated Specific Gravity		2.7	2.75	2.77	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	

Project: Sutter Bypass Weir #2	
Location: Bryte	
Project No.: 03-28	
Boring No.: SW2-1, S-3	
Sample Type: Shelby	
Description: Silty sand	
Remarks:	

Phase calculations based on start of test.
* Saturation is set to 100% for phase calculations.

Mon, 22-DEC-2003 10:01:12

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	03-943	C	15-17	DN	12/5/2003	SF		03-943C.dat
△	03-944	B	20-22	DN	12/3/2003	SF		03-944B.dat
□	03-944	C	20-22	DN	12/1/2003	SF		03-944C.dat

Project: Sutter Bypass Weir #2	Location: Bryte	Project No.: 03-28
Boring No.: SW2-1, S-3	Sample Type: Shelby	
Description: Silty sand		
Remarks:		

Mon, 22-DEC-2003 10:01:49

Sample SW2-2 Consolidated Undrained Triaxial Shear Strength Testing (CUE) Results

Sutter Bypass Weir #2

SAMPLE SW2-2, S-3; 15-17 BGS

ASTM 4767: TRIAXIAL COMPRESSION TEST RESULTS

CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEARSUREMENTS

Request No. - 2003-28 Test Date - 12/1/2003

03-954A

Effective Confining Pressure (psi) = 11.4
Dry Density (pcf) = 82.9
PI =
% Fines =
Water Content (%) = 37.0

FAILURE CRITERIA SELECTION	
Effective	
Dev. Stress @ Failure (psi)	32.5
Excess Pore Pressure @ Failure (psi)	2.5
Total	
Dev. Stress @ Failure (psi)	53.9

Axial Strain ε (%)	Excess Pore Pressure Δu (psi)	Effective Confining Stress σ_3' (psi)	Stress Ratio σ_1'/σ_3'	Deviator Stress $(\sigma_1 - \sigma_3)$ (psi)
0.00	0.00	11.38	1.01	0.09
0.10	0.11	11.27	1.03	0.34
0.20	0.23	11.15	1.04	0.40
0.50	2.30	9.08	1.50	4.52
1.00	6.10	5.28	3.09	11.01
2.00	6.14	5.25	4.13	16.40
3.00	5.11	6.28	4.48	21.84
4.00	3.87	7.51	4.61	27.11
5.00	2.48	8.91	4.65	32.52
5.10	2.35	9.03	4.66	33.06
6.00	1.02	10.36	4.65	37.88
7.00	-0.42	11.81	4.62	42.78
8.00	-1.88	13.26	4.57	47.39
9.00	-3.16	14.55	4.51	51.02
10.00	-4.32	15.71	4.43	53.86
11.00	-5.44	16.83	4.35	56.40
12.00	-6.46	17.85	4.29	58.66
13.00	-7.35	18.74	4.23	60.51
14.00	-8.26	19.64	4.14	61.68
15.00	-8.64	20.03	3.94	58.98
16.00	-7.52	18.90	3.99	56.55
17.00	-6.91	18.30	4.05	55.78
18.00	-6.83	18.21	4.09	56.24
19.00	-6.97	18.36	4.09	56.78
20.00	-7.36	18.75	4.06	57.33

03-954B

Effective Confining Pressure (psi) = 17.8
Dry Density (pcf) = 83.7
PI =
% Fines =
Water Content (%) = 38.3

FAILURE CRITERIA SELECTION	
Effective	
Dev. Stress @ Failure (psi)	41.2
Excess Pore Pressure @ Failure (psi)	7.1
Total	
Dev. Stress @ Failure (psi)	61.0

Axial Strain ε (%)	Excess Pore Pressure Δu (psi)	Effective Confining Stress σ_3' (psi)	Stress Ratio σ_1'/σ_3'	Deviator Stress $(\sigma_1 - \sigma_3)$ (psi)
0.00	0.00	17.77	1.00	-0.02
0.10	0.04	17.74	1.00	0.02
0.20	0.13	17.65	1.00	0.06
0.50	0.81	16.97	1.04	0.69
1.00	8.39	9.39	2.91	17.95
2.00	9.10	8.68	4.71	32.23
3.00	7.14	10.65	4.86	41.11
3.02	7.12	10.66	4.87	41.24
4.00	5.30	12.48	4.77	47.10
5.00	3.68	14.11	4.70	52.14
6.00	2.24	15.55	4.61	56.10
7.00	1.09	16.70	4.49	58.36
8.00	0.07	17.71	4.39	60.09
9.00	-0.86	18.65	4.27	61.03
10.00	-1.62	19.40	4.02	58.50
11.00	-1.06	18.85	3.80	52.78
12.00	0.43	17.35	3.78	48.28
13.00	1.60	16.19	3.81	45.40
14.00	2.42	15.37	3.84	43.61
15.00	2.88	14.90	3.89	42.98
16.00	3.07	14.72	3.94	43.25
17.00	3.14	14.65	3.98	43.68
18.00	3.06	14.72	4.00	44.19
19.00	2.93	14.85	4.02	44.90
20.00	2.75	15.04	4.03	45.62

03-954C

Effective Confining Pressure (psi) = 28.5
Dry Density (pcf) = 83.0
PI =
% Fines =
Water Content (%) = 34.4

FAILURE CRITERIA SELECTION	
Effective	
Dev. Stress @ Failure (psi)	52.1
Excess Pore Pressure @ Failure (psi)	15.7
Total	
Dev. Stress @ Failure (psi)	64.0

Axial Strain ε (%)	Excess Pore Pressure Δu (psi)	Effective Confining Stress σ_3' (psi)	Stress Ratio σ_1'/σ_3'	Deviator Stress $(\sigma_1 - \sigma_3)$ (psi)
0.00	0.00	28.46	1.00	0.04
0.10	0.23	28.23	1.02	0.46
0.20	0.42	28.04	1.02	0.53
0.50	1.12	27.34	1.04	1.03
1.00	10.63	17.82	2.04	18.56
2.00	17.28	11.18	4.40	38.01
3.00	16.73	11.73	5.00	46.92
3.81	15.67	12.79	5.07	52.06
4.00	15.40	13.05	5.07	53.14
5.00	13.89	14.57	5.00	58.20
6.00	12.40	16.05	4.84	61.65
7.00	10.93	17.54	4.65	63.99
8.00	9.88	18.57	4.43	63.77
9.00	9.87	18.59	4.37	62.57
10.00	9.75	18.72	4.37	63.10
11.00	9.64	18.82	4.39	63.72
12.00	9.51	18.95	4.38	64.01
13.00	9.33	19.13	4.38	64.58
14.00	9.05	19.40	4.35	65.07
15.00	8.75	19.71	4.31	65.25
16.00	8.47	19.99	4.29	65.75
17.00	8.19	20.27	4.25	65.91
18.00	7.93	20.53	4.21	65.83
19.00	7.67	20.79	4.16	65.60
20.00	7.84	20.61	4.10	63.93

Sample Cells highlighted with red text and light yellow shade require input data
Sample Cells highlighted light green - data used in calculating mohrs circles for effective (drained) stress
Sample Cells highlighted gray - data used in calculating mohrs circles for total (undrained) stress

SAMPLE NUMBER	CONFINING PRESSURE	FAILURE CRITERIA USED	DEVIATOR STRESS	PORE PRESSURE AT FAILURE	$\sigma_{3f} = \sigma_{3c} - \Delta u$
03-954A	11.38	Max stress ratio @ 5%	32.5	2.5	8.883

03-954A ; Effective Conf.Pressure = 11.38 ksc

MOHR CIRCLE RADIUS	MOHR CIRCLE MIDPOINT	VALUES FOR PLOTTING X NORMAL	Y SHEAR	CIRCLE COORD CALCULATIONS c	m
16.25	25.133	8.883	0.00	32.500	16.250
		8.964	1.62	32.338	14.627
		9.235	3.36	31.796	12.886
		9.641	4.91	30.983	11.344
		10.183	6.37	29.900	9.881
		10.996	8.01	28.275	8.238
		11.808	9.30	26.650	6.949
		12.621	10.37	25.025	5.882
		13.433	11.28	23.400	4.973
		14.246	12.06	21.775	4.187
		15.058	12.75	20.150	3.500
		15.871	13.35	18.525	2.898
		16.683	13.88	16.900	2.370
		17.496	14.34	15.275	1.907
		18.308	14.75	13.650	1.503
		19.121	15.10	12.025	1.153
		20.076	15.44	10.113	0.807
		21.160	15.76	7.947	0.493
		22.243	15.99	5.780	0.259
		23.597	16.18	3.072	0.073
		25.133	16.25	0.000	0.000
		26.669	16.18	3.072	0.073
		28.023	15.99	5.780	0.259
		29.106	15.76	7.947	0.493
		30.190	15.44	10.113	0.807
		31.146	15.10	12.025	1.153
		31.958	14.75	13.650	1.503
		32.771	14.34	15.275	1.907
		33.583	13.88	16.900	2.370
		34.396	13.35	18.525	2.898
		35.208	12.75	20.150	3.500
		36.021	12.06	21.775	4.187
		36.833	11.28	23.400	4.973
		37.646	10.37	25.025	5.882
		38.458	9.30	26.650	6.949
		39.271	8.01	28.275	8.238
		40.083	6.37	29.900	9.881
		40.625	4.91	30.983	11.344
		41.031	3.36	31.796	12.886
		41.302	1.62	32.338	14.627
		41.383	0.00	32.500	16.250

SAMPLE NUMBER	CONFINING PRESSURE	FAILURE CRITERIA USED	DEVIATOR STRESS	PORE PRESSURE AT FAILURE	$\sigma_{3f} = \sigma_{3c} - \Delta u$
03-954B	17.77		41.2	7.1	10.671

03-954B ; Effective Conf.Pressure = 17.77 ksc

MOHR CIRCLE RADIUS	MOHR CIRCLE MIDPOINT	VALUES FOR PLOTTING X NORMAL	Y SHEAR	CIRCLE COORD CALCULATIONS c	m
20.6	38.371	10.671	0.00	41.200	20.600
		10.774	2.06	40.994	18.543
		11.117	4.26	40.307	16.335
		11.632	6.22	39.277	14.380
		12.319	8.07	37.904	12.526
		13.349	10.16	35.844	10.443
		14.379	11.79	33.784	8.809
		15.409	13.14	31.724	7.456
		16.439	14.30	29.664	6.304
		17.469	15.29	27.604	5.307
		18.499	16.16	25.544	4.437
		19.529	16.93	23.484	3.674
		20.559	17.60	21.424	3.004
		21.589	18.18	19.364	2.417
		22.619	18.69	17.304	1.905
		23.649	19.14	15.244	1.462
		24.861	19.58	12.820	1.023
		26.234	19.97	10.074	0.625
		27.607	20.27	7.327	0.328
		29.324	20.51	3.894	0.092
		31.271	20.60	0.000	0.000
		33.218	20.51	3.894	0.092
		34.935	20.27	7.327	0.328
		36.308	19.97	10.074	0.625
		37.681	19.58	12.820	1.023
		38.893	19.14	15.244	1.462
		39.923	18.69	17.304	1.905
		40.953	18.18	19.364	2.417
		41.983	17.60	21.424	3.004
		43.013	16.93	23.484	3.674
		44.043	16.16	25.544	4.437
		45.073	15.29	27.604	5.307
		46.103	14.30	29.664	6.304
		47.133	13.14	31.724	7.456
		48.163	11.79	33.784	8.809
		49.193	10.16	35.844	10.443
		50.223	8.07	37.904	12.526
		50.910	6.22	39.277	14.380
		51.425	4.26	40.307	16.335
		51.768	2.06	40.994	18.543
		51.871	0.00	41.200	20.600

SAMPLE NUMBER	CONFINING PRESSURE	FAILURE CRITERIA USED	DEVIATOR STRESS	PORE PRESSURE AT FAILURE	$\sigma_{3f} = \sigma_{3c} - \Delta u$
03-954C	28.46	Max stress ratio @ 3.81%	52.1	15.7	12.757

03-954C ; Effective Conf.Pressure = 28.46 ksc

MOHR CIRCLE RADIUS	MOHR CIRCLE MIDPOINT	VALUES FOR PLOTTING X NORMAL	Y SHEAR	CIRCLE COORD CALCULATIONS c	m
26.05	38.807	12.757	0.00	52.100	26.050
		12.887	2.60	51.840	23.448
		13.321	5.39	50.971	20.657
		13.973	7.87	49.669	18.185
		14.841	10.21	47.932	15.841
		16.144	12.84	45.327	13.206
		17.446	14.91	42.722	11.140
		18.749	16.62	40.117	9.429
		20.051	18.08	37.512	7.972
		21.354	19.34	34.907	6.711
		22.656	20.44	32.302	5.611
		23.959	21.40	29.697	4.646
		25.261	22.25	27.092	3.799
		26.564	22.99	24.487	3.057
		27.866	23.64	21.882	2.409
		29.169	24.20	19.277	1.849
		30.701	24.76	16.212	1.293
		32.438	25.26	12.739	0.791
		34.174	25.63	9.266	0.415
		36.345	25.93	4.924	0.117
		38.807	26.05	0.000	0.000
		41.269	25.93	4.924	0.117
		43.440	25.63	9.266	0.415
		45.176	25.26	12.739	0.791
		46.913	24.76	16.212	1.293
		48.446	24.20	19.277	1.849
		49.748	23.64	21.882	2.409
		51.051	22.99	24.487	3.057
		52.353	22.25	27.092	3.799
		53.656	21.40	29.697	4.646
		54.958	20.44	32.302	5.611
		56.261	19.34	34.907	6.711
		57.563	18.08	37.512	7.972
		58.866	16.62	40.117	9.429
		60.168	14.91	42.722	11.140
		61.471	12.84	45.327	13.206
		62.773	10.21	47.932	15.841
		63.641	7.87	49.669	18.185
		64.293	5.39	50.971	20.657
		64.727	2.60	51.840	23.448
		64.857	0.00	52.100	26.050

Data for Shear Envelope Plot:

ϕ' (deg) =	40	phi' = 40 degrees
ϕ' (rad) =	0.6981	
C' (psf) =	0	c' = 0.0 psi = 0 psf
C' (psi) =	0.0000	

σ (ksc)	τ (ksc)
0	0.0000
10	8.3910
20	16.7820
30	25.1730
40	33.5640

SAMPLE NUMBER	FAILURE CRITERIA USED	$\sigma_{3f} = \sigma_{3c}$ CONFINING PRESSURE	DEVIATOR STRESS	FAILURE CRITERIA TO FOLLOW
03-954A	Max Dev. @ 10%	11.38	53.9	10% OR MAX. DEV.

MOHR CIRCLE RADIUS	MOHR CIRCLE MIDPOINT	VALUES FOR PLOTTING X NORMAL	Y SHEAR	CIRLCE COORD CALCULATIONS c	m
26.95	38.333	11.383	0.00	53.900	26.950
		11.518	2.69	53.631	24.258
		11.967	5.58	52.732	21.370
		12.641	8.14	51.385	18.813
		13.539	10.56	49.588	16.388
		14.687	13.29	46.893	13.662
		16.234	15.43	44.198	11.525
		17.582	17.20	41.503	9.755
		18.929	18.70	38.808	8.247
		20.277	20.01	36.113	6.943
		21.624	21.15	33.418	5.805
		22.972	22.14	30.723	4.807
		24.319	23.02	28.028	3.930
		25.667	23.79	25.333	3.162
		27.014	24.46	22.638	2.492
		28.362	25.04	19.943	1.913
		29.947	25.61	16.772	1.338
		31.743	26.13	13.179	0.818
		33.540	26.52	9.586	0.430
		35.786	26.83	5.094	0.121
		38.333	26.95	0.000	0.000
		40.880	26.83	5.094	0.121
		43.126	26.52	9.586	0.430
		44.923	26.13	13.179	0.818
		46.719	25.61	16.772	1.338
		48.305	25.04	19.943	1.913
		49.652	24.46	22.638	2.492
		51.000	23.79	25.333	3.162
		52.347	23.02	28.028	3.930
		53.695	22.14	30.723	4.807
		55.042	21.15	33.418	5.805
		56.390	20.01	36.113	6.943
		57.737	18.70	38.808	8.247
		59.085	17.20	41.503	9.755
		60.432	15.43	44.198	11.525
		61.780	13.29	46.893	13.662
		63.127	10.56	49.588	16.388
		64.025	8.14	51.385	18.813
		64.699	5.58	52.732	21.370
		65.148	2.69	53.631	24.258
		65.283	0.00	53.900	26.950

SAMPLE NUMBER	FAILURE CRITERIA USED	$\sigma_{3f} = \sigma_{3c}$ CONFINING PRESSURE	DEVIATOR STRESS	FAILURE CRITERIA TO FOLLOW
03-954B	Max Dev. @ 9.0%	17.77	61	10% OR MAX DEV.

MOHR CIRCLE RADIUS	MOHR CIRCLE MIDPOINT	VALUES FOR PLOTTING X NORMAL	Y SHEAR	CIRLCE COORD CALCULATIONS c	m
30.5	48.271	17.771	0.00	61.000	30.500
		17.924	3.05	60.695	27.454
		18.432	6.31	59.678	24.185
		19.194	9.21	58.153	21.291
		20.211	11.95	56.120	18.546
		21.736	15.04	53.070	15.462
		23.261	17.46	50.020	13.043
		24.786	19.46	46.970	11.040
		26.311	21.17	43.920	9.334
		27.836	22.64	40.870	7.858
		29.361	23.93	37.820	6.570
		30.886	25.06	34.770	5.440
		32.411	26.05	31.720	4.448
		33.936	26.92	28.670	3.579
		35.461	27.68	25.620	2.821
		36.986	28.34	22.570	2.165
		38.780	28.99	18.982	1.514
		40.813	29.57	14.915	0.926
		42.847	30.01	10.848	0.486
		45.388	30.36	5.765	0.137
		48.271	30.50	0.000	0.000
		51.154	30.36	5.765	0.137
		53.695	30.01	10.848	0.486
		55.729	29.57	14.915	0.926
		57.762	28.99	18.982	1.514
		59.556	28.34	22.570	2.165
		61.081	27.68	25.620	2.821
		62.606	26.92	28.670	3.579
		64.131	26.05	31.720	4.448
		65.656	25.06	34.770	5.440
		67.181	23.93	37.820	6.570
		68.706	22.64	40.870	7.858
		70.231	21.17	43.920	9.334
		71.756	19.46	46.970	11.040
		73.281	17.46	50.020	13.043
		74.806	15.04	53.070	15.462
		76.331	11.95	56.120	18.546
		77.348	9.21	58.153	21.291
		78.110	6.31	59.678	24.185
		78.619	3.05	60.695	27.454
		78.771	0.00	61.000	30.500

SAMPLE NUMBER	FAILURE CRITERIA USED	$\sigma_{3f} = \sigma_{3c}$ CONFINING PRESSURE	DEVIATOR STRESS	FAILURE CRITERIA TO FOLLOW
03-954C	Max Dev. @ 7.0%	28.46	64	10% OR MAX. DEV.

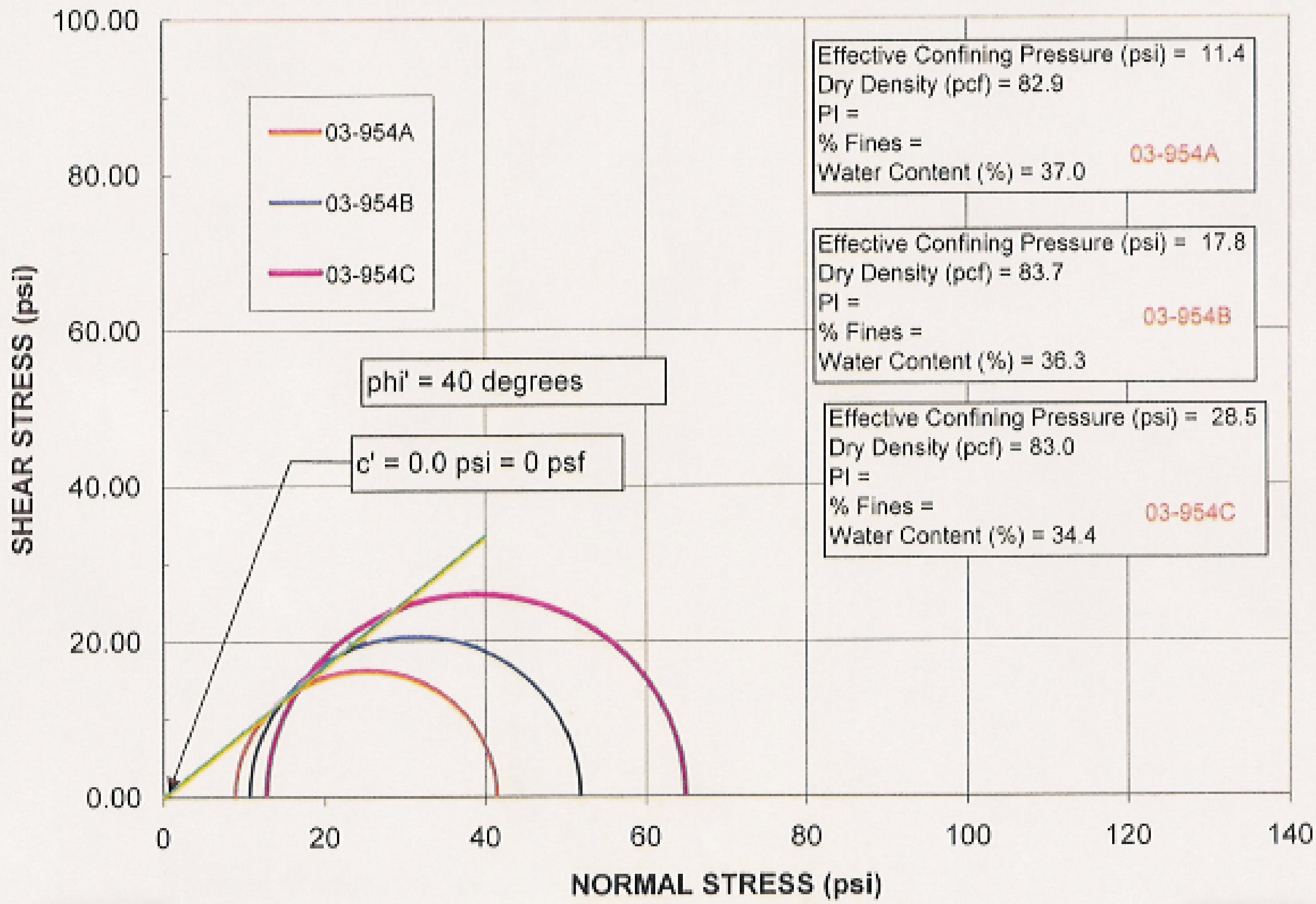
MOHR CIRCLE RADIUS	MOHR CIRCLE MIDPOINT	VALUES FOR PLOTTING X NORMAL	Y SHEAR	CIRLCE COORD CALCULATIONS c	m
32	60.457	28.457	0.00	64.000	32.000
		28.617	3.20	63.680	28.804
		29.150	6.63	62.613	25.375
		29.950	9.66	61.013	22.339
		31.017	12.54	58.880	19.459
		32.617	15.78	55.680	16.222
		34.217	18.32	52.480	13.684
		35.817	20.42	49.280	11.583
		37.417	22.21	46.080	9.793
		39.017	23.76	42.880	8.244
		40.617	25.11	39.680	6.893
		42.217	26.29	36.480	5.707
		43.817	27.33	33.280	4.667
		45.417	28.25	30.080	3.755
		47.017	29.04	26.880	2.959
		48.617	29.73	23.680	2.271
		50.499	30.41	19.915	1.589
		52.633	31.03	15.649	0.971
		54.766	31.49	11.382	0.510
		57.433	31.86	6.049	0.143
		60.457	32.00	0.000	0.000
		63.481	31.86	6.049	0.143
		66.148	31.49	11.382	0.510
		68.281	31.03	15.649	0.971
		70.415	30.41	19.915	1.589
		72.297	29.73	23.680	2.271
		73.897	29.04	26.880	2.959
		75.497	28.25	30.080	3.755
		77.097	27.33	33.280	4.667
		78.697	26.29	36.480	5.707
		80.297	25.11	39.680	6.893
		81.897	23.76	42.880	8.244
		83.497	22.21	46.080	9.793
		85.097	20.42	49.280	11.583
		86.697	18.32	52.480	13.684
		88.297	15.78	55.680	16.222
		89.897	12.54	58.880	19.459
		90.964	9.66	61.013	22.339
		91.764	6.63	62.613	25.375
		92.297	3.20	63.680	28.804
		92.457	0.00	64.000	32.000

Data for Shear Envelope Plot:

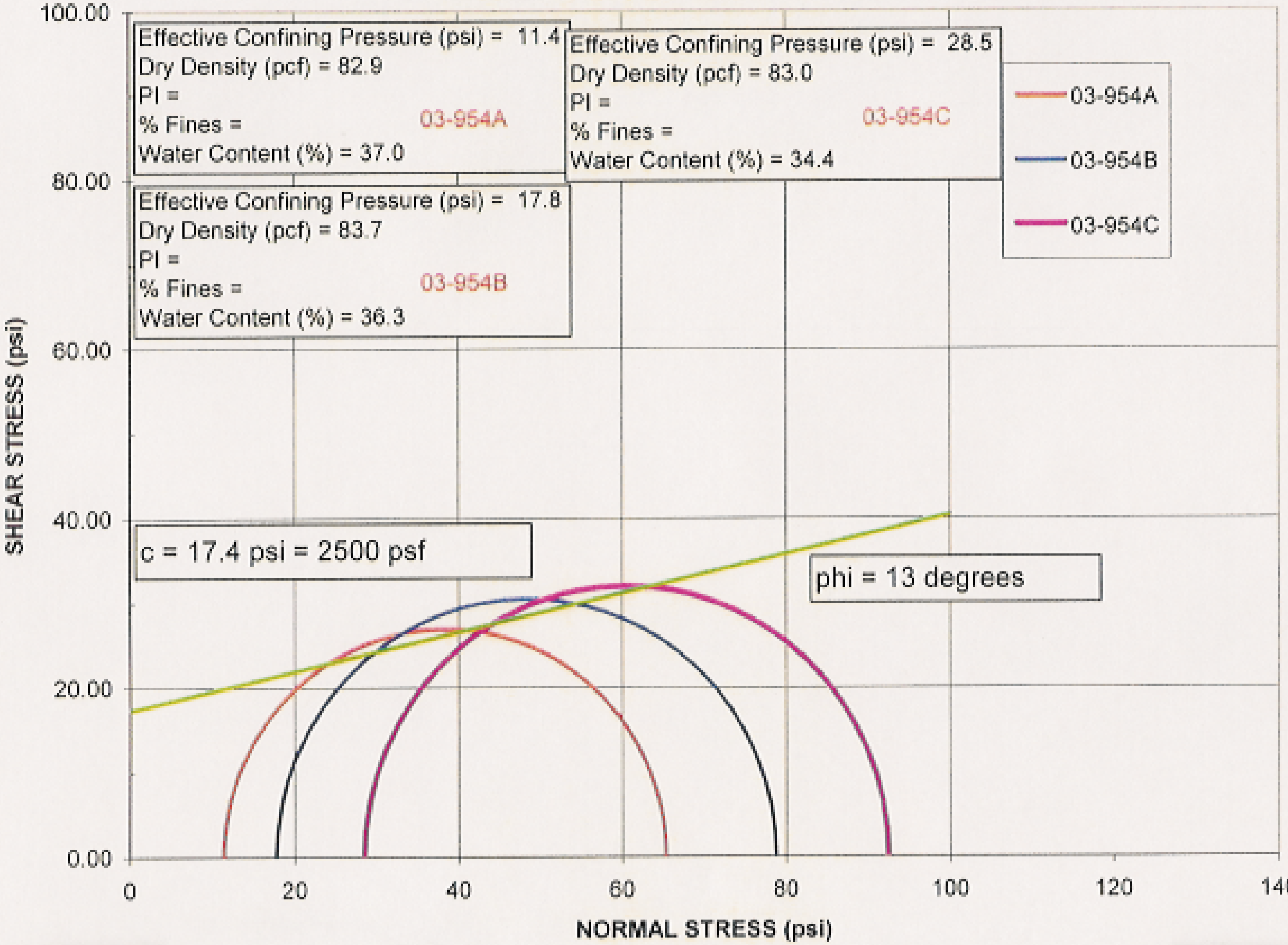
ϕ (deg) = 13 phi = 13 degrees
ϕ (rad) = 0.2269
C (psf) = 2500 c = 17.4 psi = 2500 ps
C (psi) = 17.3611

σ (psi)	τ (psi)
0	17.3611
10	19.6698
20	21.9785
30	24.2872
40	26.5958
50	28.9045
60	31.2132
100	40.4479

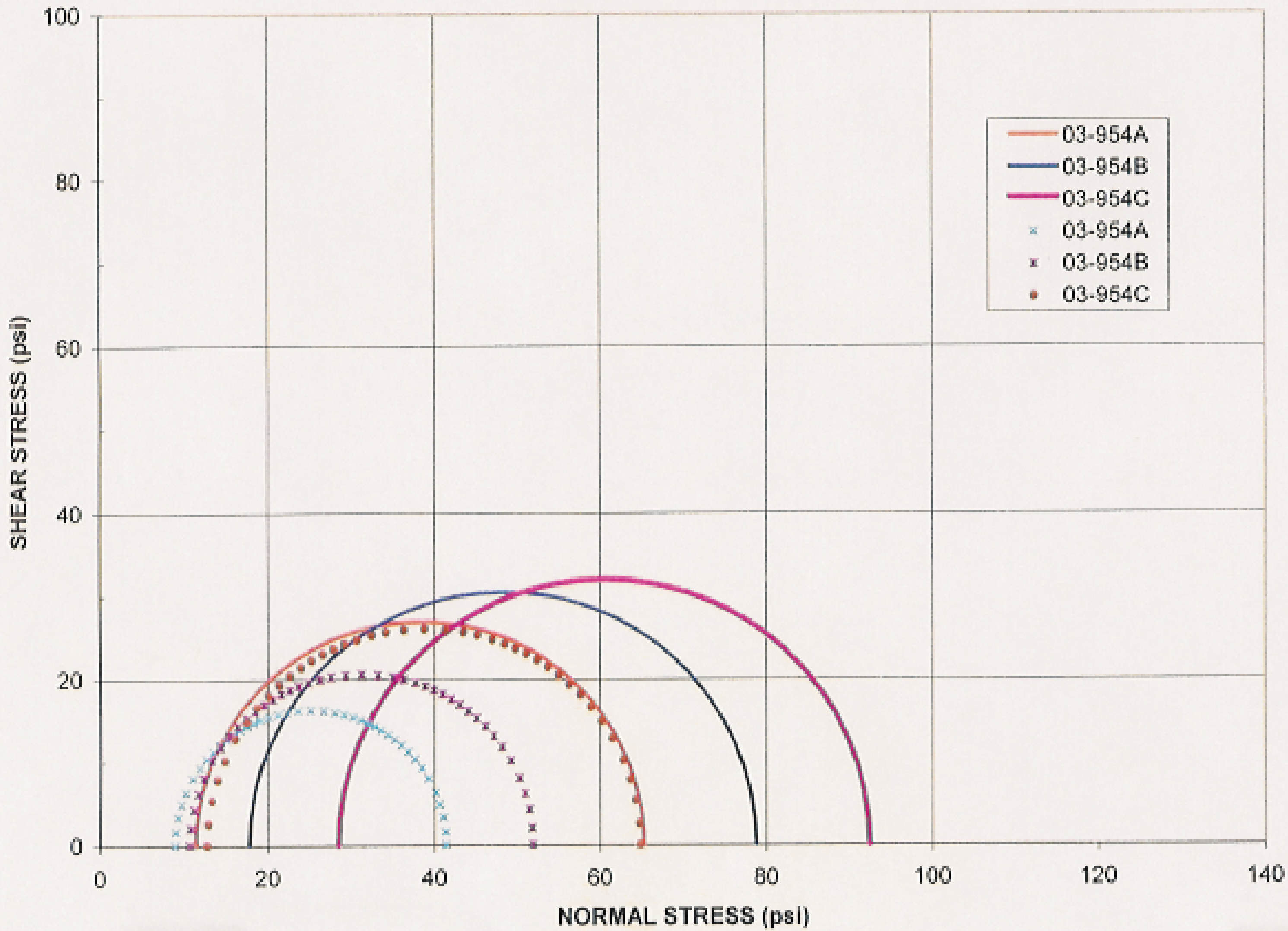
SAMPLE SW2-2, S-3; 15-17 BGS
EFFECTIVE (DRAINED) STRESS FAILURE ENVELOPE



SAMPLE SW2-2, S-3; 15-17 BGS
TOTAL (UNDRAINED) STRESS FAILURE ENVELOPES

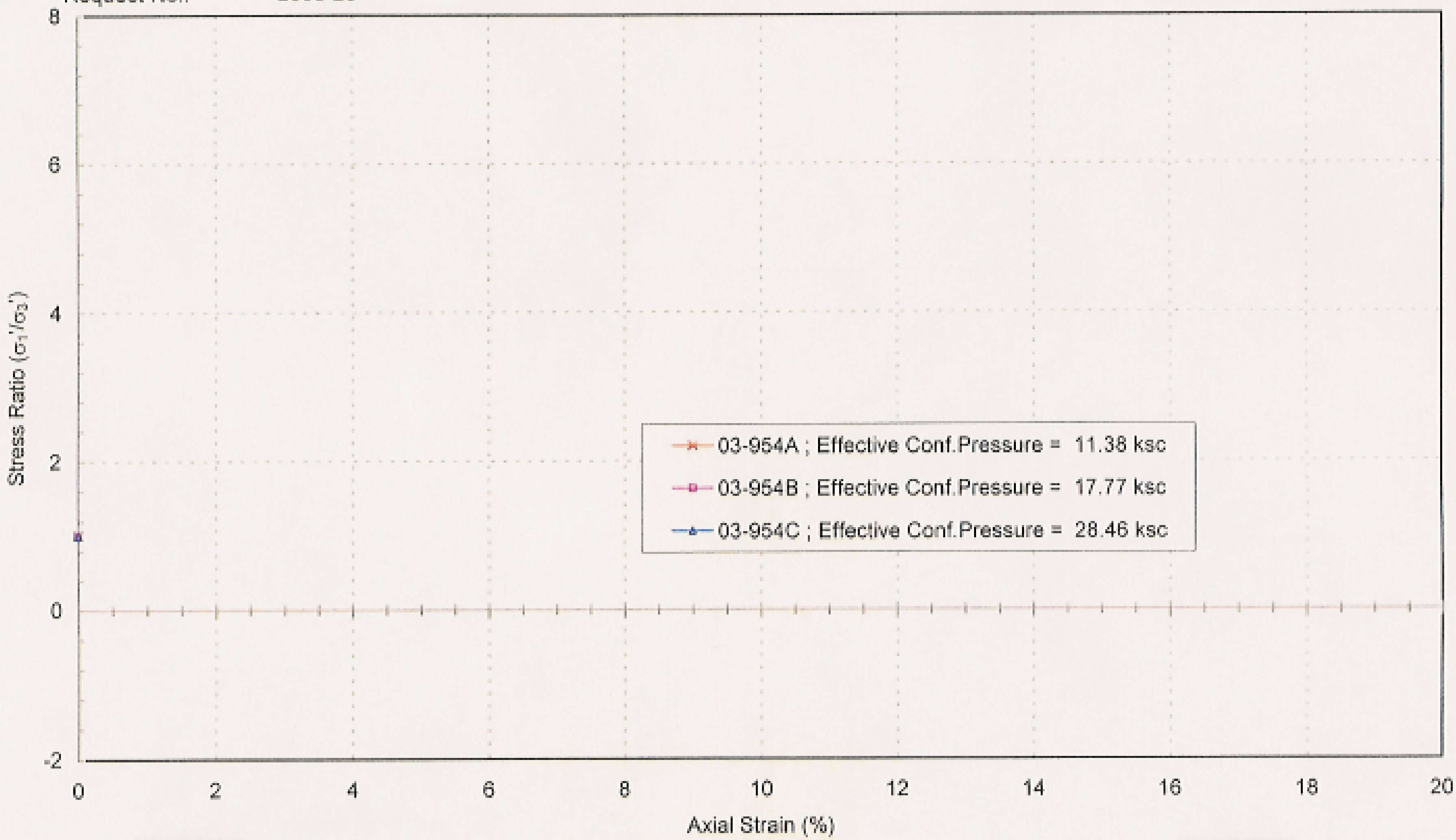


TOTAL & EFFECTIVE STRESS FAILURE ENVELOPES



TRIAXIAL COMPRESSION
ASTM 4767 : Consolidated, Undrained Compressive Strength of Cohesive Soils
Stress Ratio versus Axial Strain

Request No.: 2003-28 Test Date: 12/1/20



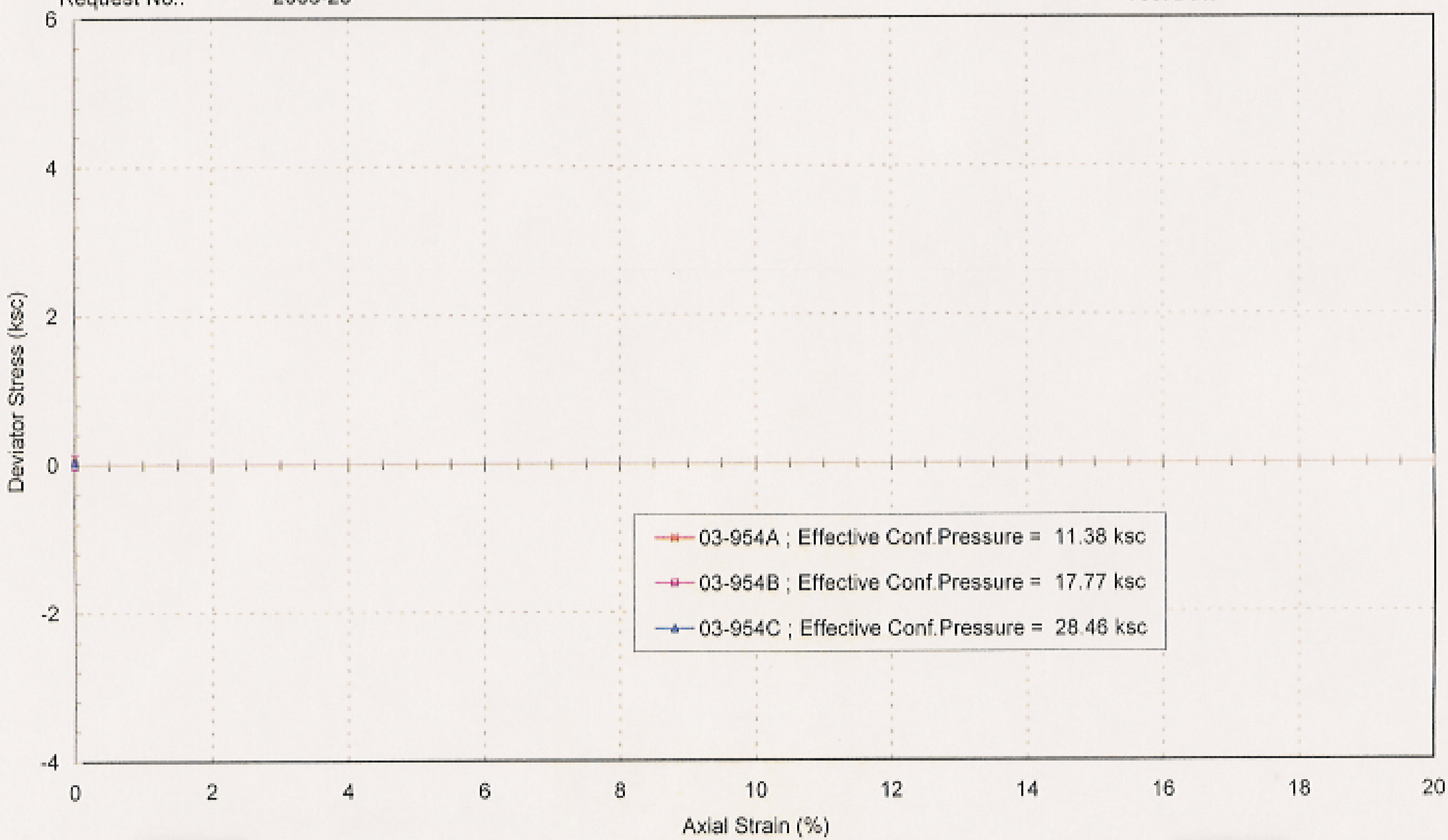
TRIAXIAL COMPRESSION

ASTM 4767 : Consolidated, Undrained Compressive Strength of Cohesive Soils

Deviator Stress versus Axial Strain

Request No.: 2003-28

Test Date: 12/1/20

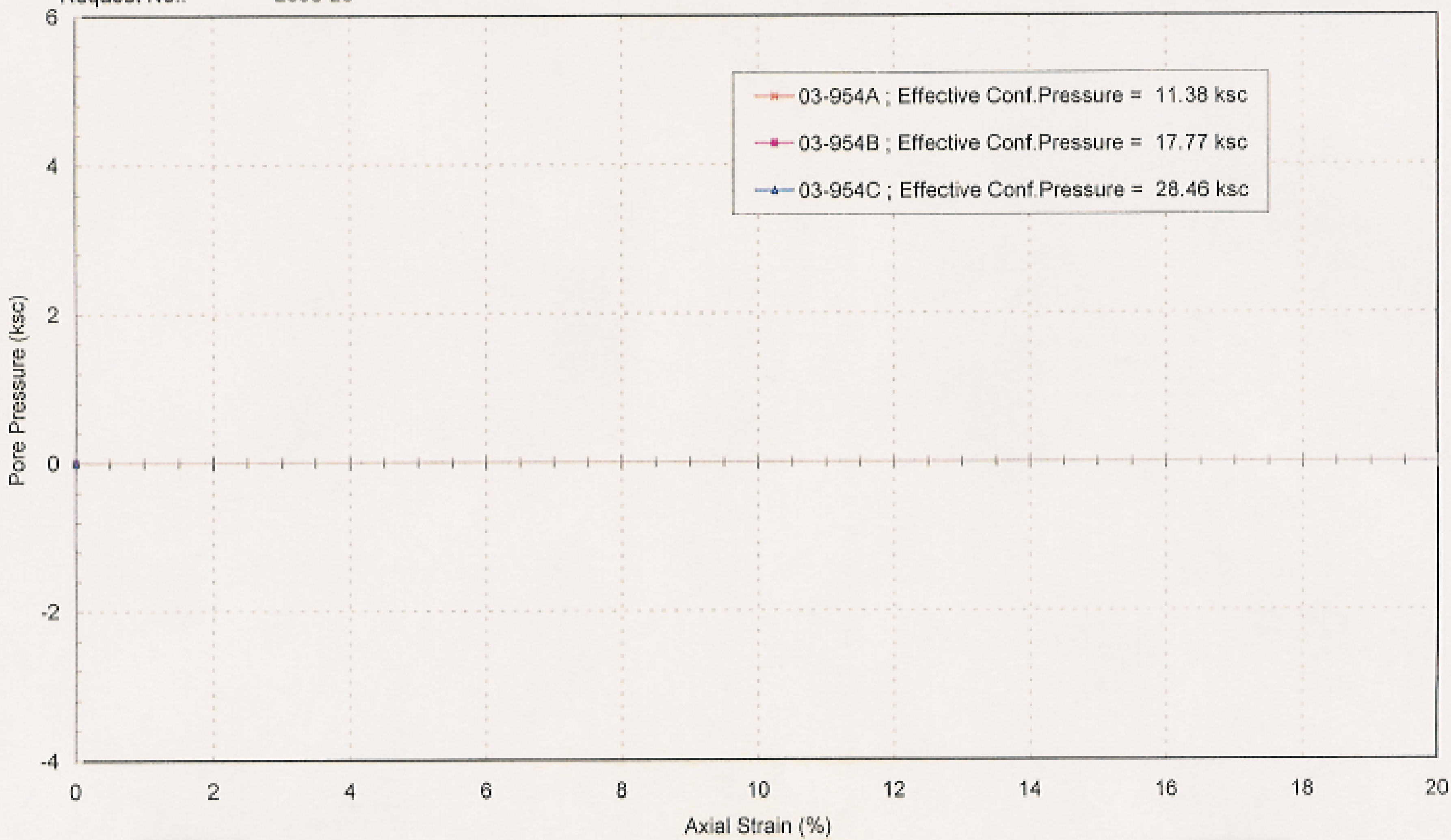


TRIAXIAL COMPRESSION

ASTM 4767 : Consolidated, Undrained Compressive Strength of Cohesive Soils

Pore Pressure versus Axial Strain

Request No.: 2003-28 Test Date: 12/1/20

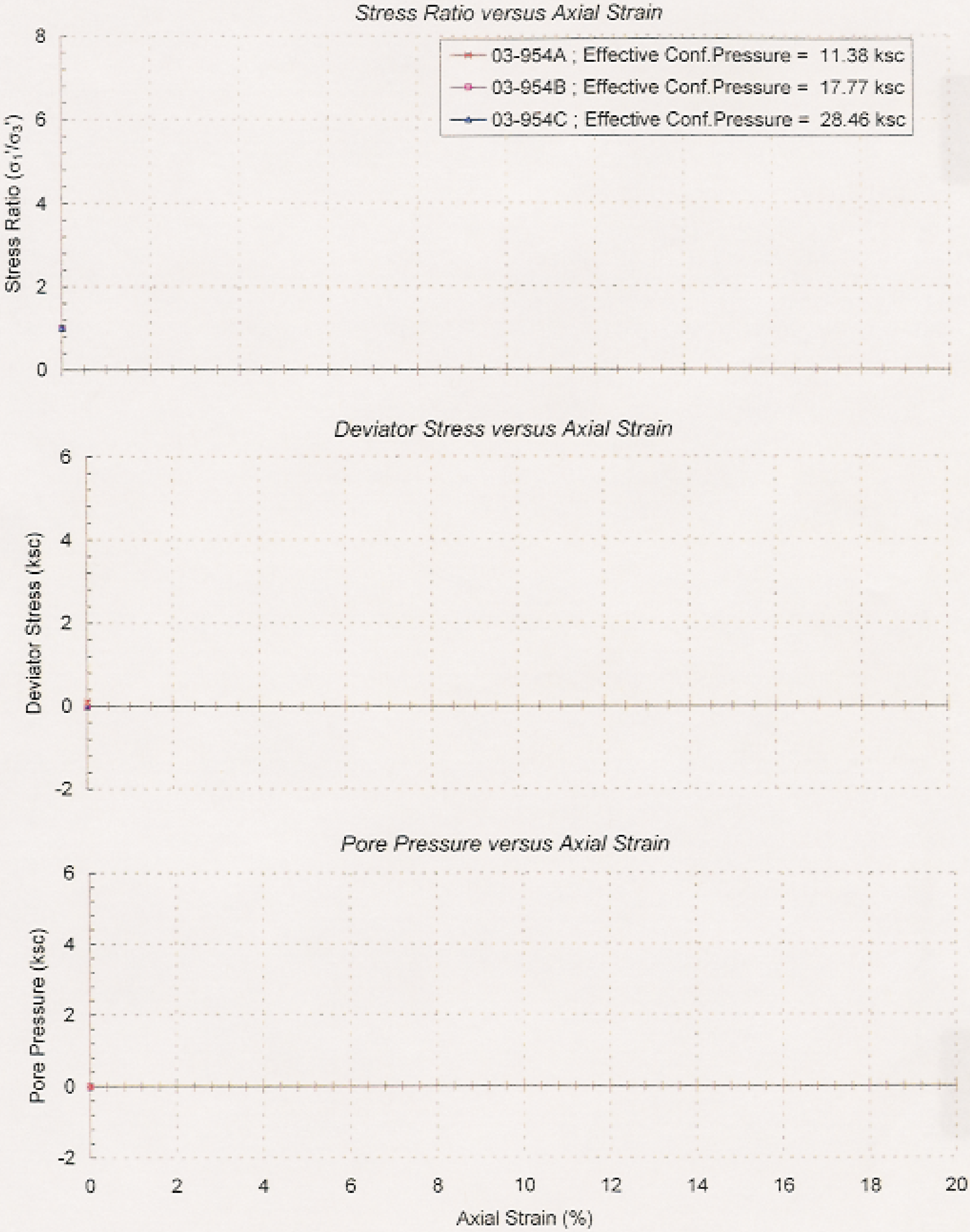


SAMPLE DA-11, S-1, 5-7.5' BGS

TRIAXIAL COMPRESSION

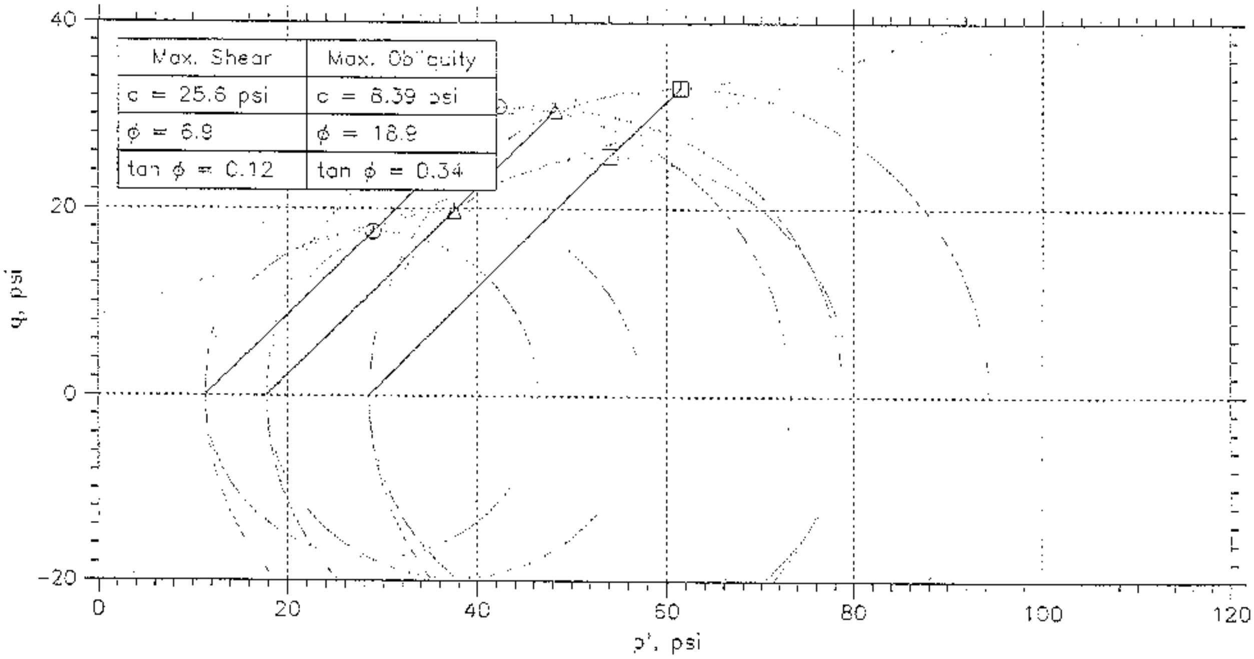
ASTM 4767: Consolidated, Undrained Compressive Strength

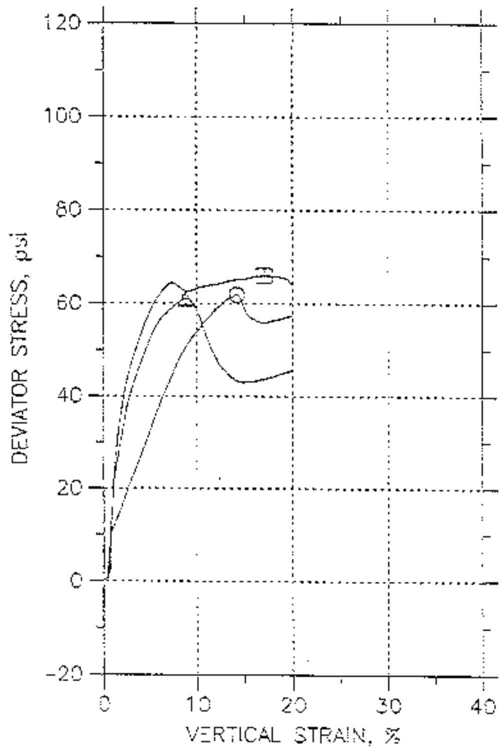
Request No.: 2003-23 Test Date: 09\9\03



SW2-2 CUE Undrained Test Results Modified with Pore Pressure Measurements

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Symbol	⊙	△	⊡	
	Sample No.	03-954	03-954	03-954	
	Test No.	A	B	C	
	Depth	15-17	15-17	15-17	
Initial	Diameter, in	2.875	2.873	2.858	
	Height, in	6.469	6.266	6.407	
	Water Content, %	37.0	36.3	34.4	
	Dry Density, pcf	82.9	83.67	82.97	
	Saturation, %	96.7	95.6	90.0	
	Void Ratio	1.03	1.01	1.03	
Before Shear	Water Content, %	36.4	36.3	34.2	
	Dry Density, pcf	84.98	85.11	87.62	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.983	0.981	0.924	
	Back Press., psi	30	32	30	
	Ver. Eff. Cons. Stress, psi	11.38	17.79	28.46	
	Shear Strength, psi	30.92	30.52	32.98	
	Strain at Failure, %	14.2	8.8	17.1	
	Strain Rate, %/min	0.05	0.05	0.05	
	B-Value	0.95	0.95	0.95	
	Estimated Specific Gravity	2.7	2.7	2.7	
	Liquid Limit	---	---	---	
	Plastic Limit	---	---	---	

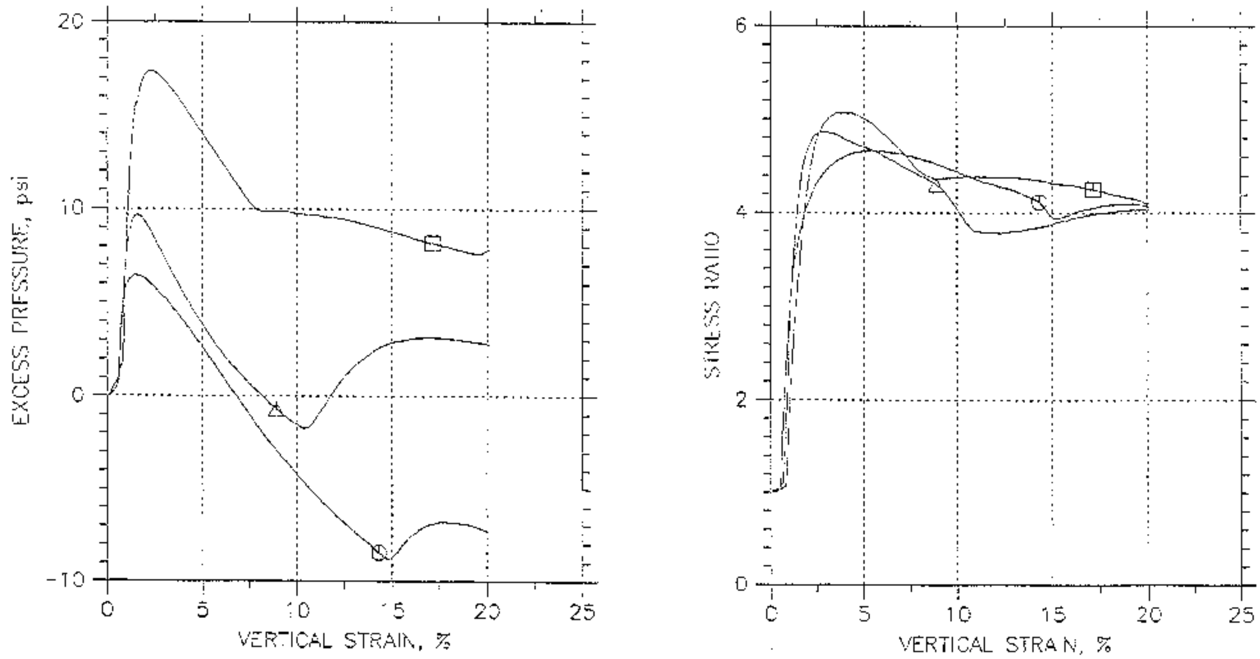
Project: Sutter Bypass Weir #2
Location: Bryte
Project No.: 03-28
Boring No.: SW2-2, S-3
Sample Type: Shelby
Description: Silty sand
Remarks:

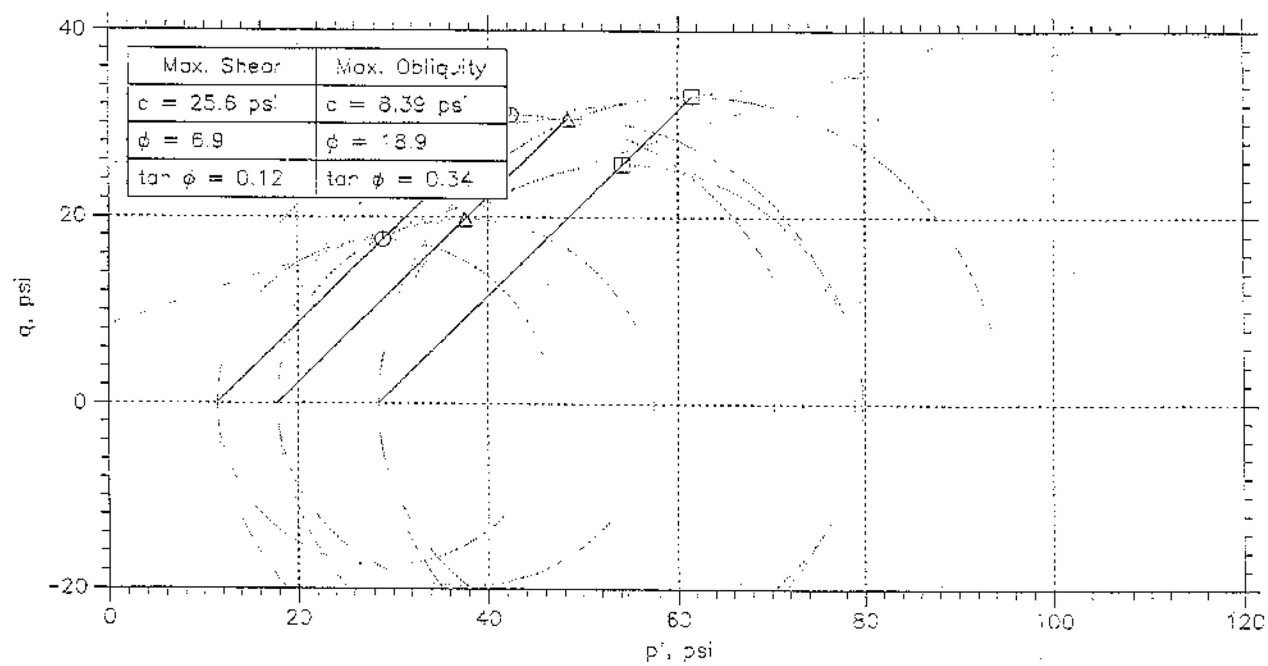
Phase calculations based on start of test.

* Saturation is set to 100% for phase calculations.

Mon, 22-DEC-2003 08:10:58

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





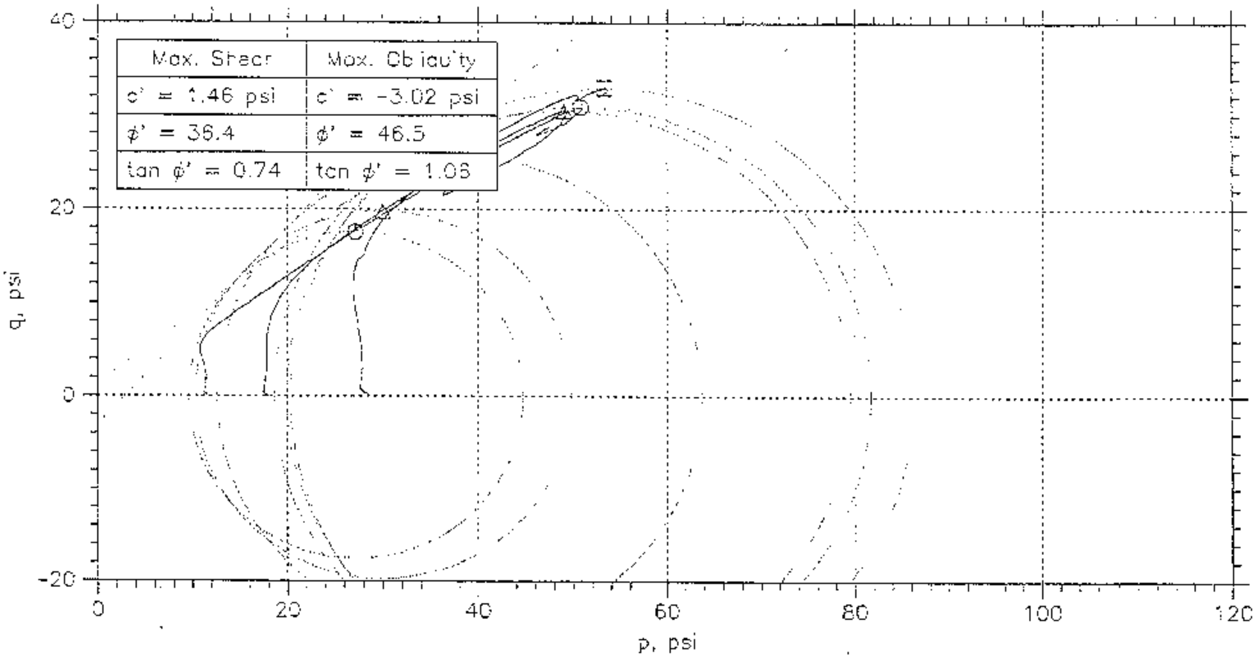
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	03-954	A	15-17	DN	12/10/2003	SF		03-954A.dat
△	03-954	B	15-17	DN	12/7/2003	SF		03-954B.dat
□	03-954	C	15-17	DN	12/7/2003	SF		03-954C.dat

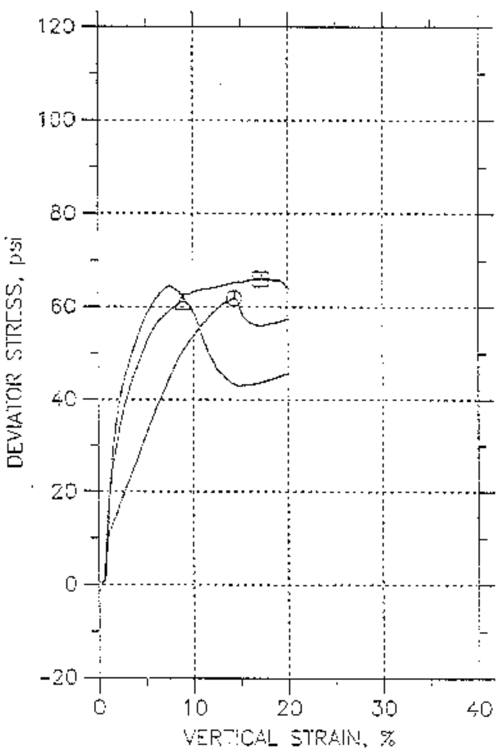
Project: Sutter Bypass Weir #2	Location: Bryte	Project No.: 03-28
Boring No.: SW2-2, S-3	Sample Type: Shelby	
Description: Silty sand		
Remarks:		

Mon, 22-DEC-2003 08:12:00

SW2-2 CUE Drained Test Results Modified with Pore Pressure Measurements

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





		○	△	□
Symbol		○	△	□
Sample No.		03-954	03-954	03-954
Test No.		A	B	C
Depth		15-17	15-17	15-17
Initial	Diameter, in	2.875	2.873	2.856
	Height, in	6.469	6.266	6.407
	Water Content, %	37.0	36.3	34.4
	Dry Density, pcf	82.9	83.67	82.97
	Saturation, %	96.7	96.6	90.0
	Void Ratio	1.03	1.01	1.03
Before Shear	Water Content, %	36.4	36.3	34.2
	Dry Density, pcf	84.98	85.11	87.62
	Saturation*, %	100.0	100.0	100.0
	Void Ratio	0.983	0.981	0.924
	Back Press., psi	30	32	30
Ver. Eff. Cons. Stress, psi		11.38	17.79	28.46
Shear Strength, psi		30.92	30.52	32.98
Strain at Failure, %		14.2	8.8	17.1
Strain Rate, %/min		0.05	0.05	0.05
B-Value		0.95	0.95	0.95
Estimated Specific Gravity		2.7	2.7	2.7
Liquid Limit		---	---	---
Plastic Limit		---	---	---

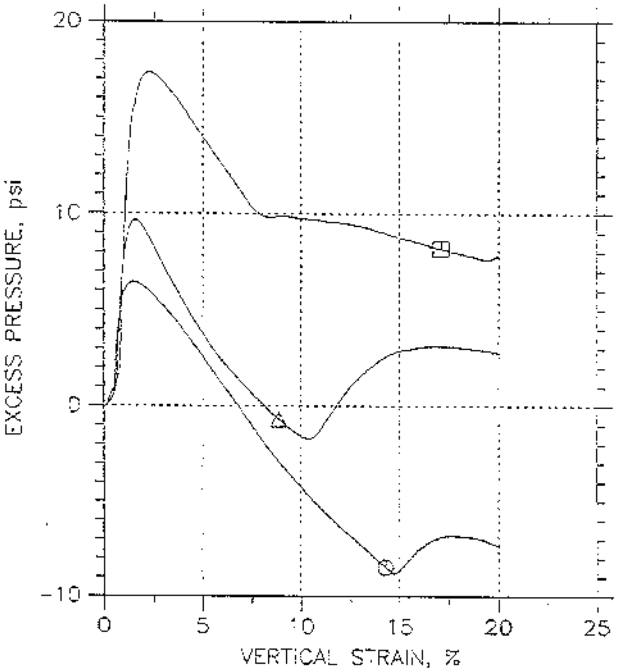
WATER RESOURCES

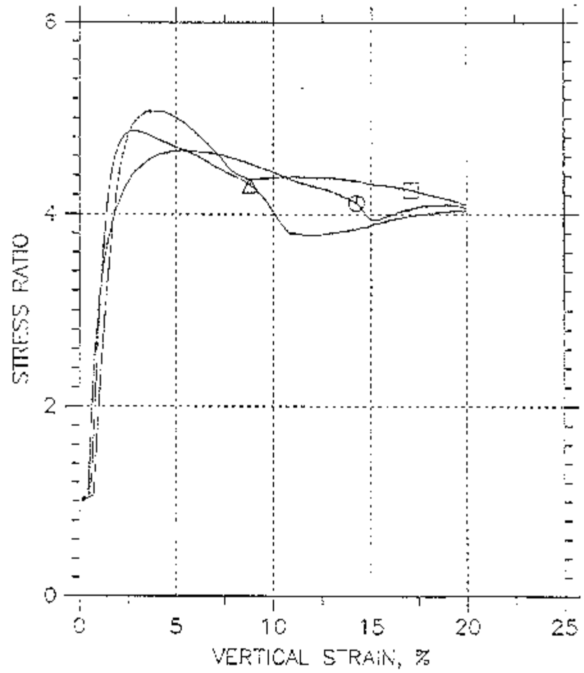
Project: Sutter Bypass Weir #2
Location: Bryte
Project No.: 03-28
Boring No.: SW2-2, S-3
Sample Type: Shelby
Description: Silty sand
Remarks:

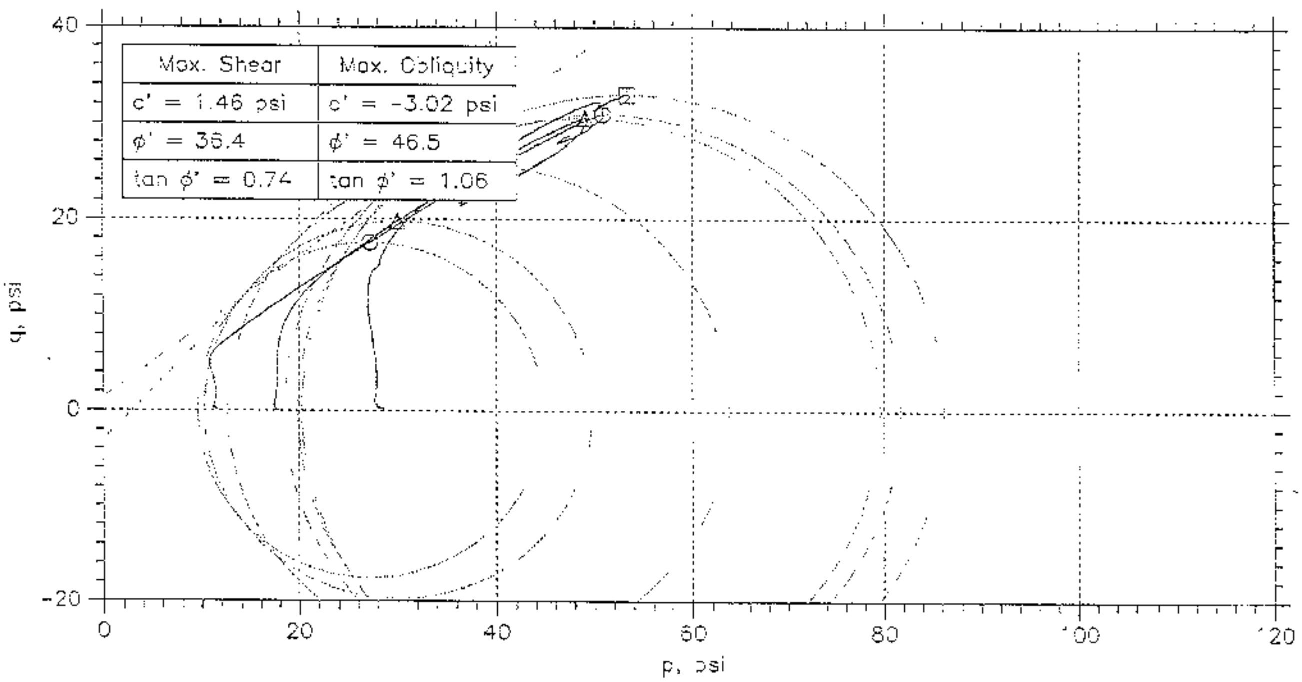
Phase calculations based on start of test.
* Saturation is set to 100% for phase calculations.

Mon, 22-DEC-2003 08:30:10

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







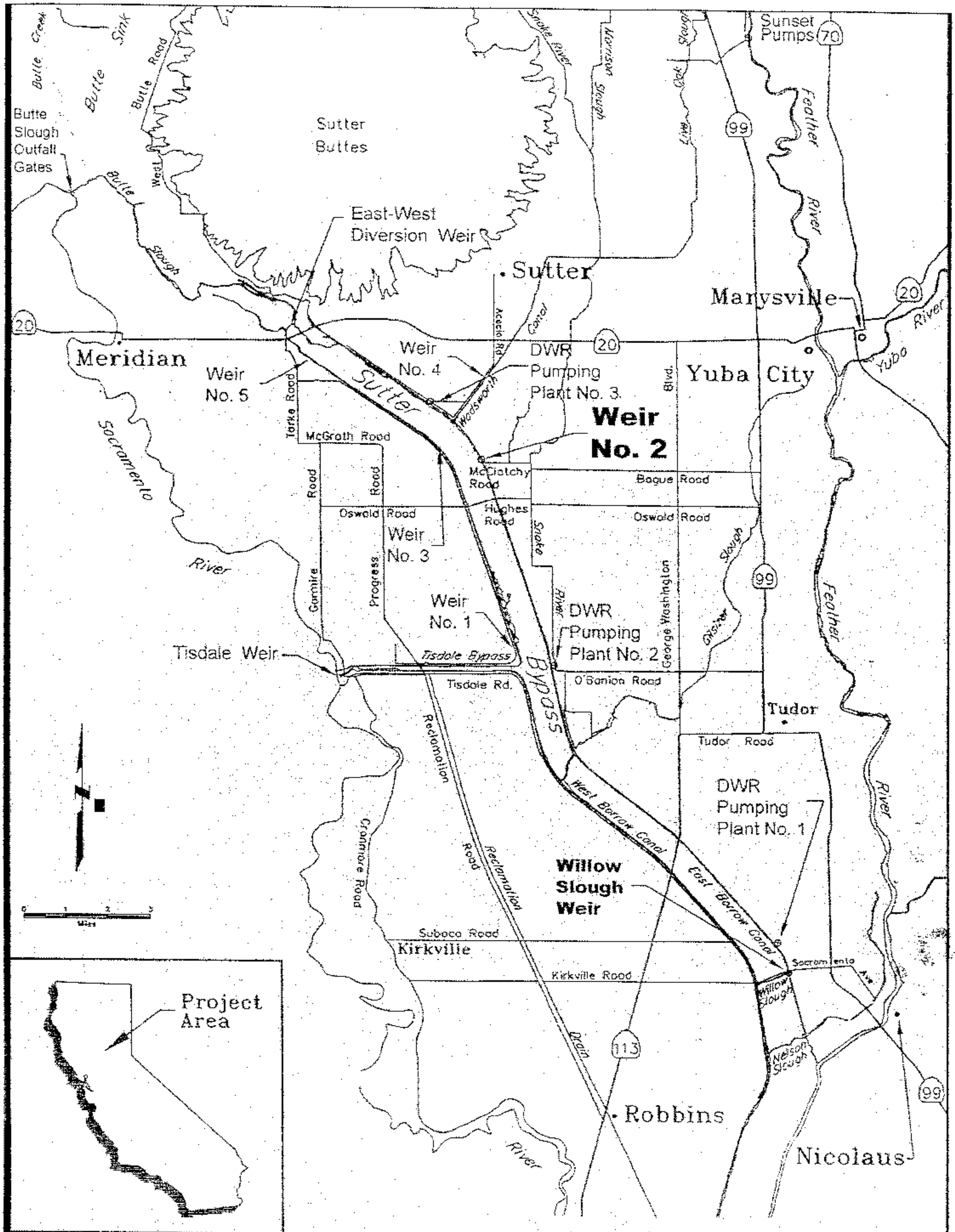
Max. Shear	Max. Obliquity
c' = 1.46 psi	c' = -3.02 psi
φ' = 36.4	φ' = 46.5
tan φ' = 0.74	tan φ' = 1.06

	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	03-954	A	15-17	DN	12/10/2003	SF		03-954A.dat
△	03-954	B	15-17	DN	12/7/2003	SF		03-954B.dat
□	03-954	C	15-17	DN	12/7/2003	SF		03-954C.dat

Project: Sutter Bypass Weir #2	Location: Bryte	Project No.: 03-28
Boring No.: SW2-2, S-3	Sample Type: Shelby	
Description: Silty sand		
Remarks:		

Mon, 22-DEC-2003 08:31:00

PLATES



GEOLOGY REPORT No. 94 00-22	GEOLOGIC MAPPING AND/OR LOGGING BY: 1 ____ 2 ____	STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES DIVISION OF ENGINEERING PROJECT GEOLOGY SECTION STATE WATER FACILITIES	SACRAMENTO RIVER FLOOD CONTROL PROJECT SUTTER BYPASS IMPROVEMENTS WEIR NO. 2 VICINITY AND LOCATION MAP	RELEASE DATE: 12-29-03
CONSTRUCTION SPEC. No.				SHEET No. 1 OF 1
GEOLOGY DRAWING No. PG-FS4-09	DRAWING PREPARED BY: Albert Loquerdio DATE:			PLATE 1

D-1

...\sutterbypass\PG-FS4-09.dgn 12/23/2003 04:55:32 PM

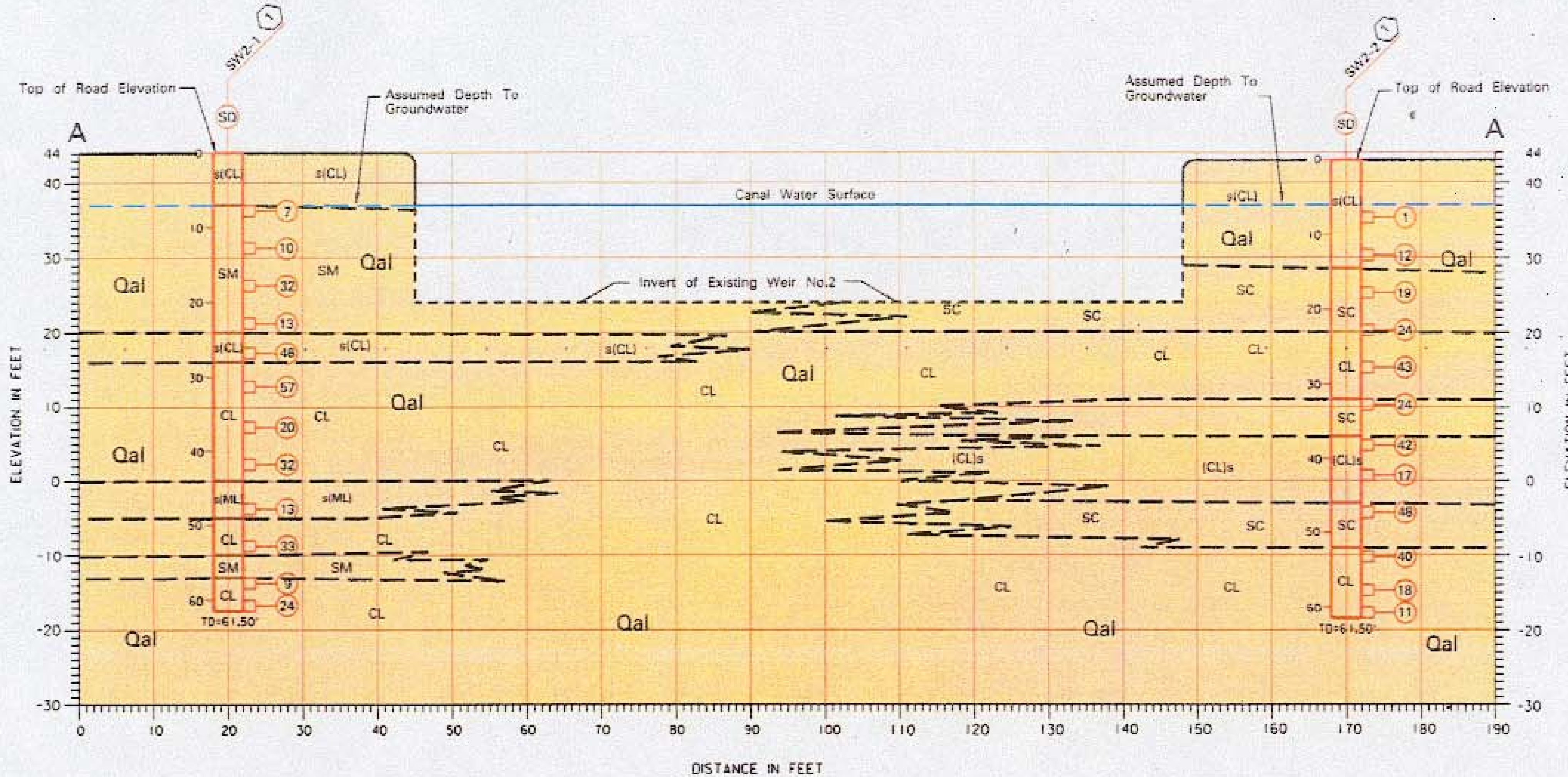
EXPLANATION

- SW2-1 — 2003 EXPLORATION DRILL HOLE
- SB-1 — APPROX. LOCATION OF 1986 EXPLORATION DRILL HOLE
- A A — GEOLOGIC CROSS-SECTION LOCATION

NOTES:

1) Locations are approximate.
2) The proposed weir structure will be located at the site of the existing weir.
3) See Plate 3 for Geologic Section A-A

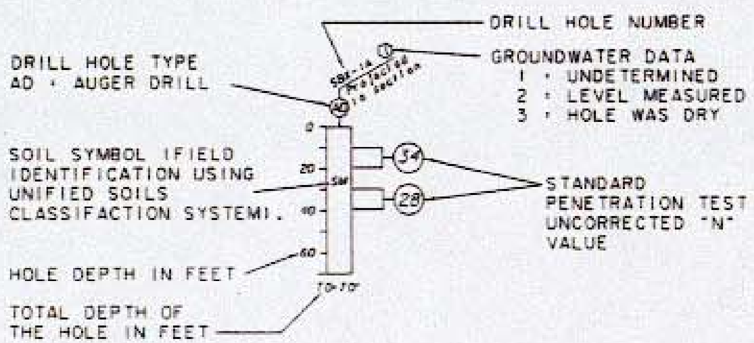
DRAWING SCALES: 1" = 100' SCALE OF FEET 50 0 50 100 150 200	GEOLOGY REPORT No. PG-94-00-22	GEOLOGIC MAPPING AND/OR LOGGING BY: 1 Tim Todd, 2 Brent Lamkin	STATE OF CALIFORNIA THE RESOURCES AGENCY	SACRAMENTO RIVER FLOOD CONTROL PROJECT SUTTER BYPASS IMPROVEMENTS WEIR NO. 2	RELEASE DATE: 12-29-03
	CONSTRUCTION SPEC. No.		DEPARTMENT OF WATER RESOURCES DIVISION OF ENGINEERING PROJECT GEOLOGY SECTION STATE WATER FACILITIES	GEOLOGIC EXPLORATION DRILL HOLE LOCATION AND GENERAL PLAN	SHEET No. 1 of 1
REV. DATE DESCRIPTION D-72	GEOLOGY DRAWING No. PG-FS4-10	DRAWING PREPARED BY: Albert Loguardio DATE:			PLATE 2



SOIL UNIT EXPLANATION

CL	-	LEAN CLAY
s(CL)	-	SANDY LEAN CLAY
(CL)s	-	LEAN CLAY WITH SAND
ML	-	SILT
s(ML)	-	SANDY SILT
SM	-	SILTY SAND
SC	-	CLAYEY SAND

DRILL HOLE EXPLANATION



CROSS SECTION EXPLANATION

Qal — QUATERNARY ALLUVIUM Actively transported and deposited

GEOLOGIC CONTACT Dashed where inferred.

NOTES:

1) Locations and depths are approximate. Some units do not correllate well between holes because of the depositional nature of flood plane deposits.

2) Soil units shown are field classifications based on the Unified Soil Classification System. Laboratory classifications may vary from those depicted. See the drill hole logs and lab classification report for more detail.

DRAWING SCALES

1" = 20' — SCALE OF FEET 10 0 10 20 30 40

GEOLOGY REPORT No.	PG-94-00-22
GEOLOGY DRAWING No.	PG-FS4-11
GEOLOGIC MAPPING AND/OR LOGGING BY:	1 TIM TODD; 2 BRENT LAMKIN
DRAWING PREPARED BY:	ALBERT LAGUARDIA

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
DIVISION OF ENGINEERING
PROJECT GEOLOGY SECTION
STATE WATER FACILITIES

SACRAMENTO RIVER FLOOD CONTROL PROJECT
SUTTER BYPASS IMPROVEMENTS
WEIR NO. 2
GEOLOGIC SECTION A-A

RELEASE DATE: 12-29-03
SHEET No. 1 OF 1
PLATE 3

REV. DATE DESCRIPTION

Appendix E Table of Contents

August 6, 2003

To: Bill McLaughlin

From: Dave Bogener

Preliminary Review of the Proposed Lower Butte Creek Sutter Bypass Weir No. 2 Fish Passage Project

Per your request, Ms. Gail Kuenster and I conducted a preliminary evaluation of the proposed fish passage project at Weir No. 2 in the Sutter Bypass. The purpose of this project is to improve fish passage over the Weir No. 2 diversion structure.

A preliminary list of potential environmental impacts associated with the proposed project is presented in Table 1. Potentially significant environmental issues related to impacts to State and federally "listed" aquatic species have been identified. I recommend that these issues be evaluated prior to initiation of final design as they may influence project design, timing, and project construction options. I further recommend that informal consultation with DFG, USF&WS, and NOAA Fisheries occur prior to final design. This informal consultation will help identify the in-channel construction period and development of project avoidance measures to minimize short-term construction related impacts to species protected under the State or federal Endangered Species acts (Table 2). Specifically, these consultations should focus on avoidance measures related to Sacramento splittail, Chinook salmon, steelhead, and giant garter snake as all of these species are known to occur within the project area and have the potential to be directly affected by the proposed project. Limited additional survey for other species including valley elderberry longhorn beetle, rose mallow, Wright's trichocoronis, and Swainson's hawk, may also be required during development of the project design. None of these species was identified during initial field reconnaissance of the immediate project area. However, access improvements, staging areas, and materials stockpiles areas were not identified at the time of the initial site survey. Further no vernal pool habitats were identified during field reconnaissance. No habitat is known to exist for Colusa layia or the San Francisco campion. Preliminary field evaluations indicate that the proposed project will not impact bank swallow, western yellow-billed cuckoo, or willow flycatcher habitat.

The proposed project will require a US Army Corp. of Engineers 404 Permit for Clean Water Act compliance (Table 3). The dredge and fill quantities involved in the project may preclude use of some Nationwide Permits (streamlined permit process) and require submittal of an individual permit which may require mitigation. The 404 permit will provide the federal nexus for a Section 7 consultation under the federal ESA. A formal ESA consultation requires up to 135 days for agency review after project design, timing, and avoidance/mitigation have been identified. Consultation with both NMFS and USF&WS will be required for project compliance. National Environmental

Protection Act compliance will be required if any federal funding is involved in the project.

A RWQCB Water Quality Certification will be required for compliance with Section 401 of the Clean Water Act. This certification will identify project specific best management practices to minimize project impacts to beneficial uses of water. These BMPs may include criteria to reduce erosion, sedimentation, hazardous material releases. BMPs will also provide criteria for de-watering and construction methods, revegetation, and monitoring requirements. A RWQCB stormwater permit may be required if total soil disturbance exceeds 5 acres. Soil disturbance would include any access improvements, staging areas; materials stockpile areas and construction areas.

A DFG Streambed Alteration Agreement (1601) will be required to address project related impacts to bed, bank, channel and associated vegetation. This agreement requires California Environmental Quality Act compliance at the time of the 1601 submittal. The proposed project could be considered categorically exempt under CEQA. At least three Categorical exemptions could be appropriate for this project including 15301-maintenance of an existing structure, 15302-replacement of an existing structure, and 15304-minor alteration of land. However, the ESA take issues may require preparation of an Initial Study and subsequent Mitigated Negative Declaration or EIR for project CEQA compliance.

Several species protected only under the State Endangered Species Act occur in this portion of Sutter County including bank swallow, willow flycatcher, western yellow-billed cuckoo, and Swainson's hawk. The project as currently designed would not result in modification of bank swallow, willow flycatcher, or western yellow-billed cuckoo habitat. However, evaluation of potential project impacts on nesting Swainson's hawks will require pre-project survey of areas within ½ mile of the project area during the nesting season to meet the survey protocol for this migratory raptor.

Weir No. 2 is old enough to require evaluation of its status as a historical structure for inclusion on the National Register of Historic Places and California Register of Historical Resources. Surface cultural features are unlikely to be present at this location due to historic sedimentation. However, buried cultural features could be uncovered during construction.

Approval of the State Reclamation Board will be required prior to working in the floodplain at this location.

Compliance with local ordinances may be required if some entity other than a State or federal Agency permits and constructs the project.

If you have any questions concerning the information provided please contact me at (530) 529-7329.

Table 1. Preliminary Environmental Issues Associated with the Proposed Lower Butte Creek-Sutter Bypass Weir No. 2 Fish Passage Project

Aesthetics	Minor, short-term construction related impacts may occur
Agricultural Resources	Minor, short-term construction related impacts may occur if agricultural lands are used for staging or materials storage
Air Quality	Minor short-term construction related impacts may require dust abatement practices
Biological Resources	Potentially significant ESA take issues related to inchannel construction window, dewatering, and dewatering screen design may occur
Cultural Resources	Assessment of the historical significance of the Weir No. 2 will be required. Potential impacts to cultural resources unlikely but project will require cultural evaluation by specialist for permitting
Geology and Soils	No issues or impacts identified
Hazards and Hazardous Materials	Increased risk of release (cement or fuel) associated with the project. Project design should minimize risk
Hydrology and Water Quality	Potential short-term impacts to water quality during dewatering and construction.
Land Use and Planning	No issues or impacts identified
Mineral Resources	No issues or impacts identified
Noise	short-term construction related impacts may occur. Limit construction activities to daylight hours.
Population and Housing	No issues or impacts identified
Public Services	No issues or impacts identified
Recreation	Short-term construction related impacts may occur related to recreational fishing.
Transportation/Traffic	No issues or impacts identified
Utilities and Service Systems	No issues or impacts identified
Public Health	No issues or impacts identified
Environmental Justice	No issues or impacts identified

Table 2. State and federally "listed" species known to occur in the project vicinity

Class	Scientific name	Common name	Status
Plants			
	Layia serptentrionalis	Colusa layia	CNPS 1B
	Silene verecunda ssp. Verecunda	San Francisco campion	CNPS 1B
	Hibiscus lasiocarpus	Rose mallow	CNPS 2
	Trichocoronis wrightii ssp. Wrightii	Wright's trichocoronis	CNPS 2
Invertebrates			
	Lepidurus packardi	vernal pool tadpole shrimp	FE
	Desmocerus californicus dimorphus	valley elderberry longhorn beetle	FT
Fish			
	Pogonichthys macrolepidotus	Sacramento splittail	FT
	Oncoryhynchus tshawyyscha	spring-run chinook salmon	ST, FT
	Oncoryhynchus tshawyyscha	fall/late fall-run chinook salmon	FC
	Oncoryhynchus tshawyyscha	winter-run chinook salmon	FE,SE
	Oncorhynchus mykiss	steelhead -Central Valley ESU	FT
Reptiles			
	Thamnophis gigas	giant garter snake	FT, ST
Birds			
	Riparia riparia	bank swallow	ST
	Empidonax traillii	willow flycatcher	ST
	Coccyzus americanus occidentalis	western yellow-billed cuckoo	SE
	Buteo swainsoni	Swainson's hawk	ST

Key
CNPS 1B-rare, threatened or endangered in California or elsewhere
FE-federal endangered
FT-federal threatened
FC-federal candidate
SE-State endangered
ST-State threatened

Table 3. Environmental Permits Potentially Required for the Proposed Lower Butte Creek-Sutter Bypass Weir No. 2 Fish Passage Project

Federal

- USACE 404 Permit-Nationwide Permit
  - Project currently appear to meet the requirements for use of USACOE Nationwide Permits
  - 404 Permit can provide federal nexus for federal ESA consultation
- Federal Endangered Species Act Compliance (see table 2)
  - Federally listed species are present, will need federal nexus for Section 7 ESA consultation
  - CALFED Funding would require preparation of an ASIP
- NEPA Compliance (if federal funds or approvals are involved)
- USF&WS special use permit (refuge lands)

State

- RWQCB 401 Water Quality Certification
- RWQCB Stormwater Permit (if ground disturbance involves more than 5 acres)
  - stormwater permit conditions can be incorporated into 401
- DFG 1600 Agreement (requires CEQA compliance)
- CEQA Compliance (Categorical exemptions may apply)
- State Endangered Species Act Compliance (see table 2)
- Reclamation Board Approvals

Local

- Sutter County grading and or tree ordinance